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ABSTRACT

This curriculum guide in environmental protection is one of 10 guides developed as part of a vocational project stressing agribusiness, natural resources, and environmental protection. The scope of this guide includes three occupational subgroups: water treatment, wastewater treatment, and air pollution control. It is meant as an aid to all who are involved in the curriculum planning phases prior to classroom instruction. Each unit has seven elements to be used for developing specific curriculum and curriculum materials: unit concept, student performance objectives, instructional areas, examples of learning activities, examples of evaluation processes, instructional materials or equipment, and references. Appendixes list recommended materials and equipment, additional references, and selected professional and technical societies. (Author/JC)

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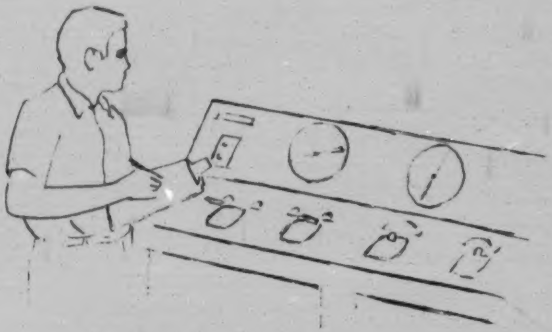

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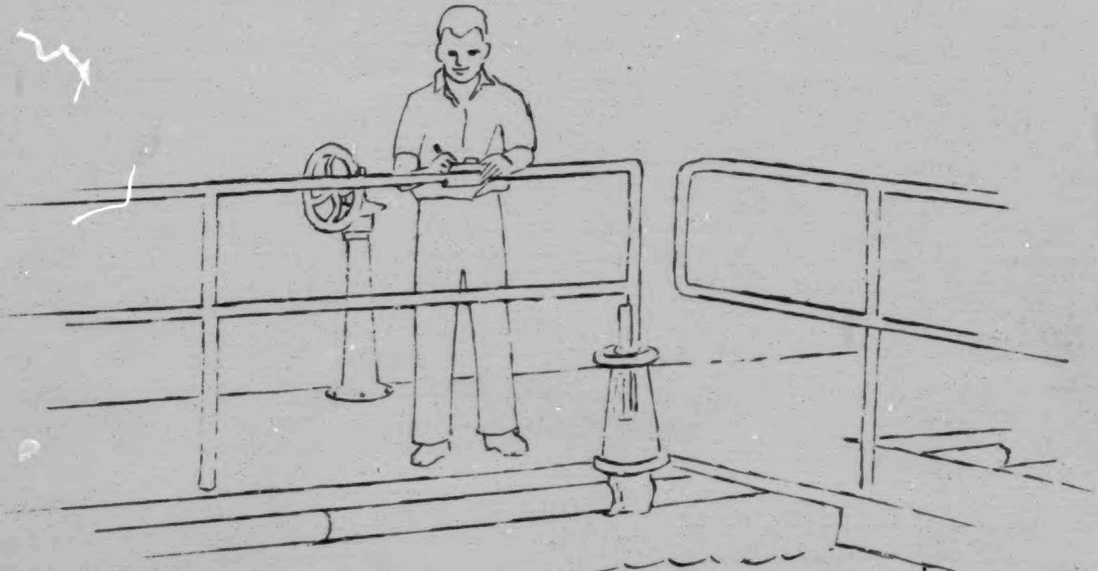
Career Preparation in

ENVIRONMENTAL PROTECTION

A Curriculum Guide

for High School Vocational Agriculture



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Career Preparation in Agricultural Production: A Curriculum Guide for High School Vocational Agriculture.

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FOREWORD

This suggested curriculum guide in Environmental Protection is one of ten guides developed under the direction of the Ohio Career Education and Curriculum Management Laboratory, Department of Agricultural Education, College of Agriculture, The Ohio State University and the Ohio Department of Education, as a part of the project entitled "Curriculum Development Basic to the Training of Individuals for Employment in Agribusiness, Natural Resources and Environmental Protection." The project was funded under a contract with the Bureau of Occupational and Adult Education, U.S. Office of Education.

The project grew out of the need to identify the eudcational experiences most appropriate for career development in agribusiness, natural resources and environmental protection. Educators were lacking adequate and accurate information for the career awareness and exploration stages of the career development process concerning the agribusiness complex. The agribusiness complex also had several emerging program areas where occupational competencies and the related curriculum had not been well defined at the vocational preparation level. These conditions caused appropriate career development programs to be lacking or ineffective at all levels, including vocational education.

In May of 1971, agricultural leaders representing state supervisors, teacher educators, classroom teachers and the agricultural business and industrial community met in Denver, Colorado, to discuss the changing nature of the field. There wa[illegible]neral agreement that the developing emphasis on agribusiness, natural resources and environmental protection called for major curriculum changes and development of new curricula, with changes in the preparation of agricultural education personnel at the same time.

The purposes of this project were: (1) to develop appropriate curriculum guides in agribusiness, natural resources and environmental protection which provide a coordinated educational program, including career awareness, career exploration and preparation for a cluster of occupations; (2) to acquaint educational leadership in all states with the curriculum materials from this project and promote their use; and (3) to disseminate copies of the curriculum materials to leaders of each state.

ACKNOWLEDGEMENTS

The programs presented in the Environmental Protection Curriculum Guide deal with two-year programs of study in the following occupational fields: water treatment, wastewater treatment, and air pollution control. Each guide is designed to assist the teacher in identifying the competencies needed for the high school student to perform the required duties of his specific job description. These are, respectively: Water Treatment Operator, Wastewater Treatment Operator, and Air Pollution Control Inspector.

The occupational areas of water treatment and wastewater treatment were developed by Dr. David Howell, Assistant Professor, Agricultural Education, Purdue University, while serving as a Curriculum Materials Specialist with the Ohio Career Education and Curriculum Management Laboratory in Agricultural Education at The Ohio State University. The air pollution control program area was developed by Tressa Scott, Curriculum Materials Specialist, also in the Ohio Career Education and Curriculum Management Laboratory. Appreciation is also extended to Dr. Elizabeth J. Simpson, Branch Chief, Curriculum Development Branch, Division of Research and Demonstration, Bureau of Occupational and Adult Education, U.S. Office of Education, and to the late Dr. Philip Teske, Project Officer, Bureau of Occupational and Adult Education, U.S. Office of Education, for their direction during the preparation of this guide. Also, gratitude is extended to the teachers and industry personnel who have given time from their jobs to assist in a critique of the guides. Appreciation also goes to Mr. Bill Farrington, Research Associate, Agricultural Education, The Ohio State University, for his technical advice throughout the development of this guide.

ADVISORY COMMITTEE

Dr. Herbert Bruce, Director, Curriculum Development Center, University of Kentucky

Dr. Irving C. Cross, Head, Agricultural Education Section, Colorado State University

William E. Guelker, Vocational Agriculture Coordinator, Area Vocational Technical School, Staples, Minnesota

Dr. William H. Hamilton, Assistant Professor, Agricultural Education, Purdue University

Amon Herd, Director, Instructional Materials Laboratory, University of Missouri

Clyde Hostetter, Director, Vocational Education Productions, California Polytechnic State University

Dr. Jasper Lee, Associate Professor, Agricultural Education, Virginia Polytechnic Institute and State University

Dr. John W. Matthews, Head, Vocational Agriculture Service, University of Illinois

Dr. Floyd G. McCormick, Head, Department of Agricultural Education, University of Arizona

Dr. Donald E. McCreight, Assistant Professor, Agricultural Education, University of Rhode Island

Arnold L. Mokma, Instructional Materials Assistant, Michigan State University

Foy Page, Coordinator, Vocational Instructional Services, Texas A & M University

Robert Patton, Assistant Coordinator, Curriculum and Instructional Materials Center, Oklahoma State Department of Vocational and Technical Education

Dr. James E. Wall, Assistant Dean and Director, Curriculum Coordinating Unit for Vocational-Technical Education, State College, Mississippi

TEACHERS AND SUPERVISORS OF SPECIALIZED HIGH SCHOOL ENVIRONMENTAL PROGRAMS

Gary Bambauer, Environmental Management Instructor, Montgomery Area Vocational Center, Clayton, Ohio (Air Pollution Control)

Ron McGuire, Environmental Management Instructor, Montgomery Area Vocational Center, Clayton, Ohio (Wastewater Treatment, Water Treatment)

Jack Newmarch, Environmental Management Instructor, Washington Park Horticulture Center, Cleveland, Ohio (Wastewater Treatment, Water Treatment)

REPRESENTATIVES OF THE ENVIRONMENTAL MANAGEMENT INDUSTRY

Jack Alberts, Morse Road Water Treatment Plant of Columbus, Columbus, Ohio

William M. Auberle, Supervisor, Regional Air Pollution Control Agency, Dayton, Ohio

Ben Bissinger, Southerly Wastewater Treatment Plant, Columbus, Ohio

Paul Craeger, Morse Road Water Treatment Plant of Columbus, Columbus, Ohio

Dick Dellenbad, Southerly Wastewater Treatment Plant, Columbus, Ohio

Pat DeLuca, Director, Steubenville Air Quality Region, Steubenville, Ohio

Jim Estep, Morse Road Water Treatment Plant of Columbus, Columbus, Ohio

John Garrett, Southerly Wastewater Treatment Plant, Columbus, Ohio

Garland Massie, Southerly Wastewater Treatment Plant, Columbus, Ohio

Dave Meir, Morse Road Water Treatment Plant of Columbus, Columbus, Ohio

Jay Miller, Morse Road Water Treatment Plant of Columbus, Columbus, Ohio

George Newell, Southerly Wastewater Treatment Plant, Columbus, Ohio

Frank Norris, Chemist, Steubenville Air Quality Region, Steubenville, Ohio

Chester J. Shura, Chief, Manpower Division, U.S. Environmental Protection Agency (Region V), Chicago, Illinois

Robert W. Williams, Sales Representative, Research Appliance Company, Allison Park, Pennsylvania

John Zobenica, Southerly Wastewater Treatment Plant, Columbus, Ohio

PROJECT STAFF

Dr. Harlan E. Ridenour	Project Administrative Director
Roger D. Roediger	Project Director
Larry D. Householder	Curriculum Specialist Associate
Max B. McGhee	Curriculum Specialist Associate
Eddie A. Moore	Curriculum Specialist Associate
Edgar P. Yoder	Curriculum Specialist Associate

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ENVIRONMENTAL PROTECTION

THE USE OF THIS CURRICULUM GUIDE

There is less than full agreement on just what constitutes a particular type of curriculum document. The curriculum guide is no exception. The following is not meant as an effort to debate curriculum terminology further, but rather to clarify how this document can be used more effectively for its intended purpose.

Entitled a curriculum guide, it is designed to answer the more basic questions of curriculum planning and development - what should be taught and, to some degree, how and with what resources. It is not intended to be taught from nor to be used as instructional material in the classroom by either teacher or students.

It is meant as an aid to all who are involved in the curriculum planning phases prior to classroom instruction. For administrators and others who must make decisions concerning facilities or equipment, specifications for facilities and equipment lists are included in the guide. For guidance counselors or others working with students on career decisions, information is provided concerning occupations and the types of competencies and characteristics needed by the workers for these occupations. For the curriculum specialist, teacher educator, state supervisor or others responsible for determining instructional content and preparing teachers to conduct instructional programs, the guide defines the needs of the students in terms of terminal performances. All other aspects of curriculum content, teaching processes and instructional resources are based upon the terminal performance objectives for the students.

The scope of the guide includes three occupational subgroups within the environmental protection area. The Water Treatment Operator, Wastewater Treatment Operator and Air Pollution Control Inspector sections of this guide provide formats for the instructor to plan a course which will prepare the student for entry level skills in these respective environmental occupations.

The units within the guide are built upon minimum levels of competencies for entry level jobs. However, it is assumed that, even though students must begin at this entry level job, many will soon be striving to advance. Whenever the employee is presented with other desirable job opportunities, it is intended that his vocational instruction will help him master early job opportunity advances in an efficient manner.

It is intended that the objectives stated in this guide would save time and effort for state personnel who have the responsibility for defining the occupational competencies in environmental protection.

Once the objectives from the guide which are common to the state curriculum needs are defined, they could be used to facilitate stating more specific levels of objectives. Or, if other objectives are more appropriate, they could be substituted for those presented as state or local conditions warranted.

ORGANIZATION OF INSTRUCTIONAL UNITS

This curriculum guide is composed of units of instruction. Each unit is developed around a closely-related group of performance objectives which are basic to the training of individuals for entry level skilled employment in environmental protection occupations. The units are organized into three environmental protection occupational areas - water treatment, wastewater treatment, and air pollution control. The instructional units are based upon the competencies of entry level skilled occupations in this area.

FORMAT OF THE UNITS OF INSTRUCTION

Each of the units of instruction have seven elements to be used for developing specific curriculum and curriculum materials. The list of elements includes:

1. Unit Concept
2. Student Performance Objectives
3. Instructional Areas
4. Examples of Student Learning Activities
5. Examples of Processes to Evaluate Student Performance
6. Instructional Materials or Equipment

7. Examples of Supporting References

A Description of the Seven Elements of the Units of Instruction

Unit Concept

The unit concept defines the rationale for the area covered by the instructional unit.

Student Performance Objectives

The student performance objectives have been considered the basic element of the units of instruction. All other elements are developed from the performance objectives. The objectives are stated in student terms at a terminal performance level. The terminal performances have been defined from an analysis of competencies necessary for successful performance in the entry level skilled occupations of environmental protection.

The performance objectives of the guide are intended to aid curriculum specialists and teachers of local environmental programs in defining the competencies which can and should be acquired by students in local programs.

It was felt that competent teachers of a vocational program would be in the best position to establish "how well" the objective should be performed, and the conditions under which it should be performed. However, conditions and standards have been indicated for most objectives. The intent is to direct attention to those conditions which may significantly affect achieving the performance and identify standards which may be especially important to success in the industry.

Instructional Areas

The performance objectives are descriptions of intended outcomes which require the acquisition of certain knowledge and skills. Titles and subtitles of instructional areas are used to define the relevant content.

Because of the specific nature of much of the learning materials needed for these instructional areas, references are cited which would be appropriate for curriculum developers. The titles for the instructional areas are of a relatively permanent nature and common to most programs. The specific content to support them is much more adversely affected by changes in technology, geographical differences or differences in local occupational characteristics.

It may be possible to use the suggested titles over a period of time with relatively minor adjustments. Specific content, on the other hand, needs to be continually updated to current conditions and matched with local student needs and occupational characteristics.

The numbering of the instructional area titles is not matched to the numbers of the student performance objectives. However, instructional areas relating to an objective can be determined relatively easily. The instructional areas are sequenced as much as is feasible in the same order as the performance objectives to which they relate

Examples of Student Learning Activities

Examples are provided suggesting ways in which students may be actively involved in learning activities that would help them achieve the objectives. They are offered as one approach that may be used rather than intended to be the complete list of activities which would provide the most effective learning. The suggested activities for each objective may or may not cover the entire objective. Therefore, development of other activities for the local program will be necessary for a comprehensive program.

Examples of Processes to Evaluate Student Performance

The student evaluation should be directed toward and based upon well-written student performance objectives. Primarily, the evaluation is to use the stated objectives as a reference point to answer the question - can the student achieve the desired performance level.

In addition, an element designated as "Examples of Processes to Evaluate Student Performance" is included in each unit of instruction. Examples of evaluation processes are intended to assist in determining the level of understanding or the ability of the student to accomplish parts of or the entire performance objective. These processes are not intended to replace a direct evaluation of the terminal performance as stated in the objective.

The type of evaluation process is determined in part by the nature of the performance objectives. But the most desirable method can be best determined when there is knowledge of the local situation, such as educational resources, school policies and the needs of the students.

Instructional Materials or Equipment

Materials or equipment are noted which are specific to the unit and which are considered essential or quite desirable in the learning process. In some cases, the objectives would be quite difficult to achieve, if at all, without the materials. In others, the materials or equipment aid in the effectiveness or efficiency of learning.

The materials and equipment suggested for one unit are not necessarily consumed or unique just to the learning activities of that unit. Lists of equipment suggested for each of the occupational areas contained in this guide are included in Appendix A.

Examples of Supporting References

A limited number of references has been listed which directly relates to the curriculum study areas suggested in the "Instructional Areas" section. These references are available and the sources or details of securing them are located in Appendix B of this guide.

When two or more references are found to have adequate learning materials and processes for the objectives of a unit but have uniquely different styles, the group may be listed so that the teacher has the choice of selecting the one most suited to his teaching.

In some cases, several references are noted because no one reference adequately covers all of the objectives of a unit or study area. Annotations of the references are provided to aid in determining which reference or references would be best suited for a local program. The reference suggested for one unit is often relevant to and suggested for use in several of the units. In no way should the references be considered the best or only references to be used with the units.

RECOMMENDED FACILITIES AND EQUIPMENT

Suggestions for Planning the Facilities for Environmental Protection Programs

The nature and the extent of the facilities needed for environmental protection instruction will be influenced by the projected enrollments, the planned use of the facilities, and the areas of emphasis to be included in the course of study. The suggestions which follow are to be considered only as guides for school facility planners and architects.

Space Allocations

Recommended minimum space allocations for accommodating twenty students per class include:

Classroom	- 720 square feet
Laboratory	- 1,200 square feet
Laboratory Storage Area	- 200 square feet
Office and Conference Room	- 200 square feet per teacher

The Classroom

The classroom should be equipped with tables and chairs to accommodate the anticipated number of students; a tack board; a chalkboard; a teacher's demonstration table with sink, running water, gas, air and electrical outlets; shelf space; storage space; and filing cabinets.

Laboratory

The laboratory should be equipped with workstations and lockers for each student, provisions for exhausting of fumes through installation of hoods, along with the necessary plumbing for water and gas. An attached storage room for high value equipment and expendable supplies is also recommended.

Recommended Equipment and Supplies

The type and quantities of equipment and supplies required to provide effective occupational education in environmental protection will depend upon several factors. These include: the anticipated age of the groups to be served; the types of groups to be served; and the emphasis to be included in the course of study in terms of the diversification or specialization.

The optimum class size is considered, for planning purposes, to be about twenty students. Sufficient quantities of equipment and supplies should be provided to make maximum use of the time available for laboratory and practical exercises. This will not necessarily require twenty duplicates of a specific item, as proper management of practical situations will seldom result in each pupil using the identical items at the same time.

An advisory committee composed of representatives from the occupational area(s) of environmental protection being taught in the local area can provide valuable assistance in developing lists of needed equipment and supplies.

A list of equipment, supplies and other instructional aids that can be used as a guide in ordering and assembling those items needed is located in Appendix A. This appendix contains separate lists for each of the occupational areas included within this guide.

TEACHER REQUIREMENTS AND RESPONSIBILITIES

In order for an environmental protection curriculum to be effective, the teaching staff must be competent and enthusiastic. The specialized nature of the occupational areas included in this curriculum guide requires that the teacher(s) have experience in a water treatment plant, wastewater treatment plant, or an air pollution control agency depending upon which occupational area he or she is employed to teach.

The teacher(s) should understand the educational philosophy, the objectives and the specific requirements of the program. They will need to be able to organize and develop programs for each individual so that he meets the requirements of the occupational cluster(s) that he is preparing to enter.

Responsibilities of the teacher(s) includes:

1. Planning a program of environmental protection including working with advisory committees and developing a curriculum to fit local needs

2. Teaching classes

3. Supervising occupational experience programs

4. Selecting and utilizing facilities and equipment

5. Advising youth organizations

6. Informing the public of program activities and students' resources

7. Utilizing community resources

8. Providing safety instruction and practices

9. Guiding and counseling students

10. Placement and follow-up of students

Motivation and morale building should be a part of every class and laboratory period. It is suggested that the instructor make an effort early in the program to establish an environment which will heighten and maintain the student's interest. The success of the program can be judged primarily by the number of students who remain gainfully employed in careers which would otherwise not have been available to them.

SCIENTIFIC AND TECHNICAL SOCIETIES AND TRADE ASSOCIATIONS

A list of some of the professional, scientific and technical societies concerned with environmental protection may be a useful source of instructional information and reference data. The selected list which follows is not a complete listing of all such organizations. Inclusion does not imply special approval of an organization, nor does omission imply disapproval of an organization. Details regarding local chapters or sections of societies have been omitted .

It is suggested that teachers and others desiring information from the organizations listed below should address their inquiry to "The Executive Secretary" of the organization.* A request for information about the organization and its services, or for specific information, usually can be answered promptly by them.

Air Pollution Control Association
American Association for the Advancement of Science

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*See Appendix C for a complete address of these organizations and associations.

American Chemical Society
American Industrial Hygiene Association
American Institute of Chemical Engineers
American Meteorological Society
American Public Works Association
American Society for Testing Materials
American Society of Mechanical Engineers
American Water Resources Association
The Citizens Advisory Committee on Environmental Quality
The Conservation Foundation
Ecological Society of America
Federal Water Pollution Control Administration
Incinerator Institute of America
Institute of Environmental Sciences
National Council for Air and Stream Improvement
National Tuberculosis and Respiratory Disease Association
National Wildlife Federation
U.S. Environmental Protection Agency
Water Pollution Control Federation

EMPLOYMENT OPPORTUNITIES IN ENVIRONMENTAL PROTECTION

Few fields offer greater occupational opportunities than the field of environmental protection and management. Manpower estimates show great needs in virtually all areas of environmental work. The following section includes general descriptions of the three occupational areas dealt with in this guide.

Water Treatment Operator
(D.O.T. No. 954.782)

General Occupational Analysis

An operator in a water treatment plant may perform any combination of the following tasks which include: operating the treatment facilities to control the flow and treatment of water, monitoring gauges, meters, and control panels, and observing variations in the operating conditions and water test results. An operator may also operate valves and gates, either manually or by remote control; backwash filters and operate lime soda ash machines; and start and stop machines and pumps to adjust flow and treatment processes. Samples are to be taken and routine laboratory tests are to be made by the operator as well as maintaining shift logs. He may also be required to perform routine maintenance functions and custodial duties.

Entry Level and Related Occupations

The entry level is as a laborer; after work experience and passing the Operator I state exam he would receive the title of Water Treatment Operator I. The related occupations include: Water Treatment Operator II, Maintenance Mechanic, Electrician, and Water Distribution Operator.

Wastewater Treatment Operator
(D.O.T. No. 954.884)

General Occupational Analysis

An operator in a wastewater treatment plant may perform any combination of the following tasks which include: inspecting and operating the bar racks, aeration blowers, sedimentation tanks, sludge digesters and sludge pumps, vacuum filters, and incinerators. The operator must also consult with other operators and supervisors on facility operations, complete information on log sheets, and do public relations work by giving plant tours. He will also collect wastewater samples and may perform such laboratory tests as settleable solids, dissolved oxygen, pH, and biochemical oxygen demand.

Entry Level and Related Occupations

The entry level is as a laborer; after work experience and passing the Operator I state exam he would receive the title of Wastewater Treatment Operator I. The related occupations include: Wastewater Treatment Operator II, Maintenance Mechanic, Electrician, and Laboratory Technician.

Air Pollution Control Inspector
(D.O.T. No. 012.281)

General Occupational Analysis

An inspector in an air pollution control agency may perform any combination of the following tasks which include: operating specific instruments to collect continuous samples of key airborn pollutants; operating specific weather instruments; recording and analyzing basic data from continuous air sampling; inspecting fuel burning equipment (particularly boilers); detecting any smoke violations (Ringlemann analysis); evaluating a community odor problem; selecting sampling station sites and installing instruments; sampling the air for radiation; assessing noise level with a decibel meter; investigating air pollution complaints; taking photographs of air pollution caused by combustion sources; assisting in obtaining evidence to substantiate legal action; writing reports for the agency; and giving evidence in court of an observed violation.

Entry Level and Advanced Occupations

The entry level is as a laborer; after work experience and given recommendation from a placement officer/instructor from his school, the student will be eligible to receive the title of Air Pollution Control Inspector I. The advanced occupations include: Air Pollution Control Inspector II, and Air Pollution Control Inspector III.

VALIDATION OF ENVIRONMENTAL PROTECTION UNITS

The units presented in the three occupational area sections in this guide have been developed through the use of varying curriculum guides and instructional materials accumulated from various sources throughout the United States. However, because the area of environmental protection has received visibility in just the past few years, the amount of comprehensive educational materials in this area is quite limited. Therefore, the units in this guide were developed almost entirely from occupational analyses conducted by the writers of the units, Dr. Howell and Ms. Scott.

The objectives cited at the beginning of the units are based upon the occupational analyses conducted by the project staff in water treatment, wastewater treatment and air pollution control facilities and agencies in Ohio.

The units included in this guide have been reviewed by various environmental management instructors in Ohio. These teachers have worked closely with environmental industry personnel in developing their programs. The units have also been reviewed extensively by representatives of the environmental protection industry which included employees and supervisors in water treatment plants, wastewater treatment plants, and air pollution control agencies.

Another phase of the validation process included the review of the guide by state and national curriculum specialists. These individuals are involved with developing curriculum materials full time and provided valuable input for the revision and improvement of this guide.

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ENVIRONMENTAL PROTECTION

UNITS GENERAL TO THE ENVIRONMENTAL PROTECTION AREAS

Occupational Opportunities in Environmental Protection

Developing Leadership through FFA

Human Relations in Environmental Protection

OCCUPATIONAL OPPORTUNITIES IN ENVIRONMENTAL PROTECTION

UNIT CONCEPT: The field of environmental protection includes a broad spectrum of career opportunities the student may wish to explore. By studying the various occupations, the student is able to consider various factors, such as working conditions, salary and requirements for entry that will influence his career choice.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. In seeking information about job opportunities, conduct surveys or obtain literature which will assist him in determining the number and kind of job opportunities that are available in environmental protection.

2. Given a specific career in which the student is interested, determine the competencies and requirements needed by persons to enter and advance in that career.

3. Upon determining the requirements and competencies needed to enter a job, develop a personal plan which will aid him in acquiring the competencies and meeting the requirements needed for entry in that job.

4. Upon identifying a job in which he is interested, follow the proper procedures necessary to become placed on the job.

5. Upon securing placement on a job, work with other employees, the employer and/or customers in a manner that will enable the student to succeed on the job.

B. INSTRUCTIONAL AREAS

1. Assessing the job opportunities available in environmental protection
   - a. Locating information regarding the scope of environmental protection occupations and the opportunities for employment

   b. Surveying the local region for entry level jobs regarding the number of openings per year and future employment needs

2. Making a detailed study of selected environmental protection occupations

   a. Determining personal interests and how they relate to a specific job or cluster of occupations

   b. Assessing the competencies that are needed for entry

   c. Determining the educational requirements necessary for employment

   d. Assessing the personal traits required by the occupation

   e. Determining the worker benefits in a given occupation

   f. Considering state and federal regulations which apply to various occupations

3. Developing a personal plan for obtaining experiences necessary for gainful employment in a given occupational area

   a. Planning activities that will enable the student to be exposed to experiences which will aid in his employment

   b. Working with cooperators in developing the occupational experience record

   c. Recording the activities of the occupational experience program

   d. Supervising and evaluating the student's occupational experience program

4. Securing a job

   a. Locating potential jobs through various sources

   b. Assessing the job description and the student's interests

   c. Considering political aspects of the job

   d. Applying for a job

        (1) Writing a letter of application
        (2) Preparing a resume
        (3) Securing references and recommendations

    e. Completing the required comprehensive examination for the job

    f. Participating in the personal interview

5. Considering factors important to job success and advancement

    a. Establishing rapport with fellow employees, the public and the employer

    b. Determining the impact of personal grooming upon the public, the employer and fellow employees

    c. Following directions and working independently in an occupation

    d. Developing desirable work habits

    e. Continuing self improvement on the job

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Conduct a survey by personal contact or questionnaire of environmental protection agencies to determine the number of personnel employed in various jobs in environmental protection and the number of openings each year.

2. Interview several persons in specific occupations and determine the competencies and requirements needed to enter the occupation.

3. a. Write a letter of application and fill out an application form. Have the class members critique them.

    b. Visit the managers of area environmental protection agencies and public utilities and discuss with them the factors they consider in hiring an employee.

4. Using simulation techniques, have the students role-play job interviews. Record the interviews on a tape recorder and have each student critique his own presentation. To guide the students

in the critique, have the class develop a list of criteria for job interviews and check themselves against these criteria.

5. Using a panel composed of employers and employees, have the class discuss with them the development and maintenance of working relationships between employees and employer.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Using a list of environmental protection job titles, have the students match these to the most appropriate environmental protection area. These job titles could also be matched to level of position, such as skilled, semi-skilled, technical and professional. These tasks should be accomplished with 90% accuracy to allow for variation in job title names.

2. Have each student complete a survey of a given occupation or cluster of occupations which assesses the competencies needed for employment, the educational requirements for gaining employment and the personal characteristics needed for successful employment, to the satisfaction of the teacher.

3. Have each student complete a personal plan for obtaining employment in his desired occupation which should include the necessary educational and work experiences in addition to any special competencies that need to be acquired.

4. Have each student develop a list of points to remember or a check list for writing a letter of application for a particular job. This list should include such items as neatness, proper introduction of applicant, where applicant can be contacted, request for necessary application forms, completeness, and personal references.

5. The teacher should evaluate each student as to his ability to work with others in the classroom, while involved in organizational activities, and/or in a cooperative placement situation. The student should complete a personal evaluation sheet to be used when discussing his abilities, attributes, and weaknesses with the teacher.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Samples of job application forms, letters of application, occupational survey forms, personal characteristics check lists, and

copies of state and federal labor regulations

2. Appropriate tables, desks, chairs and tape recorder or video tape machines necessary for conducting simulated job interviews

3. Written notices from newspapers, journals and other publications listing various job openings

F. EXAMPLES OF SUPPORTING REFERENCES

1. Occupational Opportunities in Environmental Management. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1972, 48 pages.

   This reference provides practical, easy to read descriptions of the daily work performed by environmental protection employees.

2. Opportunities in Agricultural Occupations and the Employee within the Business Organization. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1971, pp. 3-43.

   A student manual, this reference may be helpful when covering such topics as applying for a job, assessing one's personal characteristics, and locating job opportunities.

DEVELOPING LEADERSHIP THROUGH FFA

UNIT CONCEPT: Active participation in the FFA will provide the student opportunities for developing practical training in agriculture, leadership, cooperation and citizenship.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Using the basic principles of leadership, identify the role of the FFA organization in environmental protection education.
2. Using the official FFA manual, identify the history, aims and purposes, and organization of the FFA on the local, state and national level.
3. By actively participating in the organization's business meetings, demonstrate the principles of parliamentary procedure as presented in Robert's Rules of Order or other acceptable references.
4. Through active participation in the organization, serve effectively as a committee member and/or chairman in planning and carrying out the chapter program of activities.
5. If elected, serve effectively as an officer in the organization by fulfilling the duties of the office to which elected.
6. Through chapter and classroom activities, develop effective public speaking skills so as to be able to make introductions, participate in conversations and prepare and deliver speeches and talks.
7. Through active participation in the FFA, develop a strong self concept and a positive attitude toward working in society as evidenced by his public and private activities.

B. INSTRUCTIONAL AREAS

1. Developing leadership

   - a. Purposes for attaining leadership skills
   - b. Types of leadership
     - (1) Formal leadership
     - (2) Informal leadership
   - c. Qualities of leadership
   - d. Styles of leadership
   - e. Functions of democratic leadership
   - f. Opportunities for developing leadership abilities
     - (1) Home
     - (2) School
     - (3) Community
     - (4) FFA

2. Determining the place of FFA in environmental protection education
   - a. The values of FFA membership
   - b. The contribution of the FFA to the school and community
3. Determining the background of the FFA
   - a. Important historical facts
   - b. Aims and purposes
   - c. Colors, emblem, motto and creed
4. Governing and financing the FFA
   - a. Local
   - b. State
   - c. National
5. Attaining FFA membership and degrees
   - a. Types of membership

   b. Local, state and national degrees

6. Planning and conducting a chapter meeting

   a. Identifying officer responsibilities

   b. Identifying member responsibilities

   c. Conducting the business meeting

7. Planning and conducting the chapter program of activities

   a. Identifying areas to be included

   b. Developing a program of activities

   c. Carrying out the program of activities

      (1) Identifying chairman responsibilities
      (2) Identifying committee member responsibilities

8. Performing FFA officer duties and responsibilities

   a. Identifying qualifications for local, state and national offices

   b. Identifying specific duties of each officer

   c. Determining general responsibilities of an officer

      (1) Conducting chapter programs
      (2) Participating in officer meetings
      (3) Participating in leadership activities
      (4) Conducting chapter meetings

9. Developing proficiency in parliamentary procedure

   a. Presiding over meetings

   b. Presenting motions correctly

10. Developing public speaking skills

   a. Developing conversation skills

   b. Making introductions

c. Preparing a speech or talk

d. Delivering a speech or talk

11. Determining responsibilities of FFA members

a. Developing personal attributes

(1) Personal appearance
(2) Proper manners
(3) Behavior in public

b. Using the FFA code of ethics

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Analyze the qualities of recognized good leaders.

2. Attend state and/or national FFA conventions to observe the operation of the organization.

3. a. Participate in classroom study and practice of parliamentary procedure to develop parliamentary procedure skills.

b. Plan and post agenda in advance of regular chapter meetings to promote attendance and participation by all members.

c. Attend and participate in FFA meetings to develop leadership abilities.

d. Prepare for and participate in parliamentary procedure demonstrations and contests.

4. a. Accept an FFA committee assignment suited to interest and ability, to develop skills in committee work.

b. Serve as a committee chairman to develop leadership skills.

c. Prepare written and oral committee reports and present them at FFA meetings to develop personal skills and to facilitate operation of the organization.

d. Participate in special training programs for committee chairmen to obtain skills in committee work.

5. a. Arrange for election of FFA officers and participate as an officer, if elected.

   b. Plan, conduct and/or participate in leadership workshops or officer-training programs.

   c. Establish performance standards for local FFA officers.

6. a. Participate in classroom discussions, demonstrations, oral and written reports, and local public speaking competition.

   b. Enter public speaking contests above the local level.

   c. Participate in leadership activities above the local level.

   d. Practice making formal introductions through role-playing.

   e. Have each student prepare a short talk or speech to present in class, using a tape recorder or video tape for the student to hear and/or observe his performance.

7. Conduct a self-evaluation of leadership qualities, personality characteristics, and other personal attributes, identifying strong points to build upon and weak points needing improvement.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Have each student list the qualities of a democratic leader so that attainment of the qualities would result in a person displaying democratic leadership.

2. Develop a matching test in which each student would match the parts of the FFA emblem with what it symbolizes with complete accuracy.

3. Divide the class into groups to present a business meeting. The teacher should evaluate each group and member as to their poise and knowledge of parliamentary procedure.

4. Have each member assigned responsibilities for assisting in planning and conducting the chapter program of activities. Evaluate each member in reference to completion of his assigned tasks and the improvement that he exhibits over each grading period.

5. Have the secretary, treasurer, and reporter regularly submit their books to the auditing committee and teacher for evaluation as to completeness, neatness and accuracy.

6. Conduct a public speaking contest in each class for the teacher to evaluate each student for his presentation in relation to his speaking abilities.

7. Have each student complete a personal evaluation form as to his attitudes toward himself and society. The teacher should privately discuss the personal evaluation with each student to recognize strong points and weak points needing improvement.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Official FFA paraphernalia
2. Official FFA secretary's and treasurer's books
3. Official FFA scrapbook
4. Tape recorder or video tape

F. EXAMPLES OF SUPPORTING REFERENCES

1. Bender, Ralph E. The FFA and You. Danville, Illinois: The Interstate Printers and Publishers, Inc. 1962, 494 pages.

   This text covers all areas of FFA program activities as well as officer and member duties and responsibilities. It is an excellent reference for beginning members and officers.

2. Membership - Pathway to Leadership. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1972, 23 pages.

   An aid for teacher unit planning and for the student, this booklet emphasizes fundamental leadership competencies to be developed by all members.

3. Official Manual, Future Farmers of America. Alexandria, Virginia: Future Farmers Supply Service. 1972, 128 pages.

This manual will assist both members and advisors in gaining an understanding of the history, organization, and operation of the FFA.

4. Stewart, W. F. Helps in Mastering Parliamentary Procedure. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1969, 17 pages.

A simple and easily understood booklet containing the basic rules of parliamentary procedure. It also includes a quick reference chart with requirements for each type of motion.

HUMAN RELATIONS IN ENVIRONMENTAL PROTECTION

UNIT CONCEPT: Many jobs are lost because of poor human relations between employee, employer and supervisor. Human relations in today's society is a "two-way street" as the employee has a role or responsibility and loyalty to the employer and the employer has certain responsibilities to the employees. The human relations process focuses upon the ability to present ideas and the ability to listen as people relate to each other.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. While preparing for an occupation in environmental protection, conduct a self-evaluation of his physical appearance, speech and conversation, and personality as it relates to relations with other persons, to the satisfaction of the teacher.

2. While working in an environmental protection occupation, improve his relations with other personnel as evaluated by the employer, utilizing criteria such as appearance, punctuality, dependability, production, initiative and cooperation.

3. When meeting and working with employers, fellow employees or supervisors, communicate effectively orally or in writing with these persons, to the satisfaction of the teacher and/or employer.

B. INSTRUCTIONAL AREAS

1. Determining how people fail and succeed on the job

   a. Identifying common causes of job failure

   b. Recognizing the various human needs and motives that are satisfied by occupations

   c. Recognizing how human motives and needs affect the human relations process

2. Identifying human relations roles and situations in environmental protection occupations
    a. Assessing the employee's role
    b. Assessing the employer's role
    c. Assessing the foreman's or supervisor's role
3. Considering factors that influence the human relations process in environmental protection occupations
    a. Assessing the influence of personality in human relations
        (1) Considering factors that influence personality
        (2) Controlling and improving your personality
    b. Relating with your fellow employees
        (1) Identifying feelings and attitudes that affect human relations with fellow employees
        (2) Cooperating with fellow employees to create a productive and pleasant work environment
    c. Relating with the foreman or supervisor
        (1) Improving attitudes toward supervision
        (2) Accepting criticism, advice and praise
        (3) Cooperating with supervisors in recognizing and solving problems that affect the organization
4. Developing speaking and writing skills
    a. Conducting and participating in conversations and discussions
    b. Using the telephone effectively
    c. Speaking in public
    d. Writing legibly and effectively

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Have each student complete a self-inventory of his personality. Compare the student's ratings with the ratings of others who are

inventorying his personality, such as the teacher or employer.

2. a. Have the students conduct a questionnaire survey of environmental protection agencies and public utilities to determine the major factors that resulted in persons losing their jobs during the last five years.

   b. Have an employer, foreman or supervisor from an environmental protection agency or a public agency visit with the class to discuss the importance of establishing good human relations with fellow employees, employer, and supervisors.

3. Hold a local public speaking contest with each student giving a speech or talk concerning a facet of environmental protection.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Have each student conduct a self inventory of his physical appearance, speech and conversation, and personality to be used in evaluation meetings with the teacher or employer providing occupational work experience to identify personal strengths and weaknesses.

2. Have each student list eight human relations skills that are important in environmental protection occupations.

3. Video tape each student as he gives a talk or speech or participates in a discussion session so that the teacher and student can evaluate his performance.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Appropriate classroom equipment such as tape recorder, telephone, and video tape equipment

2. Appropriate forms for self evaluation

F. EXAMPLES OF SUPPORTING REFERENCES

1. Course of Study in Agricultural Occupations. Lexington, Kentucky: Department of Agricultural Education, University of Kentucky. 1967, 262 pages.

This reference, which is most helpful to teachers, covers in outline form the various areas of human relations. Forms are provided which may be completed to evaluate certain aspects of human relations with fellow workers and for employer-teacher evaluation of the student.

2. Human Relations in Business. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1971, 70 pages.

   The student reference includes brief yet comprehensive discussions and exercises which the student can read and complete to obtain a better understanding of the human relations process.

3. Resource Unit on Human Relations. Tucson, Arizona: Department of Agricultural Education, The University of Arizona. 1971, 90 pages.

   An excellent reference for teachers, the complete area of human relations is covered in outline form. Numerous case problems are presented for students and teachers to consider during discussion periods. Various rating forms for self-evaluation are included which the students may complete. Sample test items are also included.

II

WATER TREATMENT

Water Sources and Uses.

Collection of a Water Sample

Water Quality

Chlorination

Chemical Coagulation

Sedimentation

Filtration

Water Softening

Aeration

Pumps and Pumping

Water Storage

Water Distribution

Flow Measurement

Bacteriology

WATER TREATMENT (Continued)

Reports and Records

Safety

Chemistry in a Water Treatment Plant

Mathematics in a Water Treatment Plant

WATER SOURCES AND USES

UNIT CONCEPT: Even though the source of water on the earth is quite large and remains constant, the quantity or quality can become inadequate in certain areas because of adverse environmental conditions or because of pollution and poor management by man.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. From a diagram of the hydrologic cycle, explain the cycle including how it relates to water supplies used by man, and each of the processes of precipitation, perculation or runoff, and evaporation.
2. Describe the major sources of surface water supplies and the safety of water from such sources.
3. List the advantages and disadvantages of ground water supplies.
4. Determine the water consumption rates in his local community, as calculated by community services or governmental agencies.
5. Identify the future problems of supplying water and how the supply is limited for the local conditions.

B. INSTRUCTIONAL AREAS

1. The hydrologic cycle - the endless movement of water
2. Surface water supplies
    a. Precipitation and runoff
    b. Safe yield of surface water supplies
    c. Quality of surface water supplies
    d. Rivers and lakes

  - e. Impounding reservoirs
  - f. Sanitation and control of water sources

3. Ground water supplies
   - a. Types of ground water sources
   - b. Deep wells
   - c. Springs

4. Water consumption - dependent on size and character of the community

5. Future supply problems
   - a. Concerned with both quantity and quality
   - b. Salt water conversion

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Make a drawing of the hydrologic cycle.
2. Determine the average water consumption rates in the local community on a yearly, monthly, and daily average.
3. Visit the local water treatment plant and discuss the source of water, the plant capacity, and the rate of water consumption during the year.

D. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Have each student explain the hydrologic cycle well enough that each of the processes of precipitation, runoff, and evaporation are related to the water supplies.
2. Have each student list and discuss the major sources of water and the advantages and disadvantages of each, including safety aspects from each source.

3. Have the class collect and exhibit data from current and accurate information of local water consumption rates, to the satisfaction of the instructor.

4. Have each student list those factors which limit our use of water today.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Chart of the hydrologic cycle

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 3-17.[1]

   A discussion is provided on the precipitation and runoff in the United States and the safe yield of surface water supplies. Wells and springs are considered as the major sources of ground water. Water consumption rates and future water supplies are also considered.

2. Water Works Operation. Unit I. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 1-6.[2]

   This reference describes the major domestic, public and industrial, uses of water. Typical levels of use for each area are described and the physical characteristics of water are introduced.

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[1] This manual will be referred to, in text, as the "New York Manual." It is available from Health Education Service at P. O. Box 7283, Albany, New York, 12224.

[2] This reference will be referred to, in text, as the "Texas Manual."

COLLECTION OF A WATER SAMPLE

UNIT CONCEPT: The sampling method is very important in securing a representative water sample. The method used must be adapted to the type of water source.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Describe the purpose and need for taking representative water samples, to the satisfaction of the instructor.

2. Properly collect a representative sample under various conditions for the laboratory.

    a. Samples of raw water

    b. Samples of treated water

3. Decide the frequency of sampling needed for water supplies from various sources.

B. INSTRUCTIONAL AREAS

1. Representative sampling

    a. Ponds or reservoirs

    b. Flowing streams or rivers

    c. Well supplies

    d. Distribution and supply pipes

        (1) Raw water
        (2) Treated water

2. Frequency of sampling

  - a. Ponds or reservoirs
  - b. Flowing streams or rivers
  - c. Well supplies
  - d. Distribution and supply pipes

3. Proper sampling procedures
  - a. Bacteriology
  - b. Color
  - c. Odor

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

Collect a water sample using the following instructions: When collecting a water sample, it is important to select a location which is representative of the body of water. The collection of water too close to the shore or within stagnant areas may not yield a representative sample. A thorough analysis involves sample collection at varying depths, about every 3 feet. However, analysis for recreation usage requires only that a sample be taken one foot under the surface in the middle of the swimming area. For larger streams or rivers, a sterile device can be lowered from a bridge into the main current and filled. The sample must not be contaminated by surface scum or unnatural turbidity at any time during or after the collection.

Procedure:

1. Remove the foil hood and paper strip from the stopper of the sterile bottle.

2. Place the entire bottle under the water in an inverted position and turn it upright. Keep your hands clear of the water entering the bottle. In moving water, it is wise to keep your hands downstream relative to the neck of the bottle.

3. Fill the bottle about 2/3 full and replace the stopper while the entire unit is still submerged. The air space is left in the bottle

to allow adequate mixing of the sample later. The bottle should remain sealed until the sample is needed. It must be refrigerated if there is to be a time lapse prior to culturing. (A maximum storage time should be set at six hours.)

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

Have each student demonstrate the proper methods of collecting representative samples of both raw and treated water from various sources. The sources should include ponded water or lakes, flowing streams (surface water), well supplies, and distribution pipes. He should also be able to determine the frequency of sampling needed under various conditions.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Autoclave, horizontal 22" inside diameter, 35" long, or other suitable sterilizing equipment
2. A 10% solution of sodium thiosulfate
3. Twenty or more 250 milliliter sterilized collection bottles containing one milliliter of a 10% sodium thiosulfate solution (added before sterilization).

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 259-262.

   This material includes a discussion of what constitutes a representative sample, the procedure to use in sampling and how often sampling is necessary.

WATER QUALITY

UNIT CONCEPT: A determination of the impurities present in water must be made since water seldom occurs in a chemically pure state in nature.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. List some important characteristics to consider in terms of the "quality" of water.
2. Explain the reasons for water treatment.
3. Demonstrate the important water quality control tests that an Operator I is expected to perform in the water treatment plant.
4. Identify the limits in concentration of specific substances in drinking water.

B. INSTRUCTIONAL AREAS

1. Reasons for water treatment
    a. To protect the health of the community
    b. To supply a product which is esthetically desirable
    c. To protect the property of the consumers
2. Quality control tests
    a. Tests relating to the protection of the health of the community include the measurement of numbers of coliform bacteria and determination of the chlorine residual.
    b. Tests relating to the production of an esthetically desirable product include color, turbidity, suspended solids and temperature.

c. Tests relating to the protection of the consumer's property include pH, acidity, alkalinity, total hardness, and calcium.

3. Drinking water standards

   a. Bacteriological quality

   b. Turbidity

      (1) Color
      (2) Threshold odor

   c. Chemical substances

   d. Radioactivity

4. Composition of water from various sources

   a. Rain water contains gases of the atmosphere, dust, and other solid materials collected from the air. In general, it is very soft, low in total solids and alkalinity, below neutral in pH, and very corrosive to metals.

   b. Ground water in a given area reflects the geology of the region - the composition of the underlying rock formation and of the soils derived from them. The presence of readily soluble formations near the surface such as gypsum, rock salt, or limestone may cause marked effects upon the waters of the area. However, less soluble formation such as sandstone or granite do little to effect the composition of the water.

   c. If there is to be a selection of a water source from several sources, then the following seven considerations should be studied:

      (1) Absence of harmful concentrations of poisonous chemical substances
      (2) Absence of the causative microorganisms and viruses of disease
      (3) Lowest possible levels of color, turbidity, suspended solids, odor, and taste
      (4) Lowest possible temperature
      (5) Minimum corrosivity to metals

    (6) Least possible tendency to deposit scales
    (7) Lowest possible content of staining materials, such as iron, manganese, and copper

5. Self-purification and storage

    a. In general, self-purification results in the removal of organic matter. The degree to which it occurs depends upon the dilution, the effectiveness of re-aeration, sedimentation, and, most important, the time interval available for biochemical action.

    b. Storage of water and time are factors which are conducive to algae growth and other forms of microscopic plant and animal life which cause tastes and odors to develop in the water.

6. Methods of water treatment - The main objective of most water treatment is the reduction of the total quantity of foreign substances in the water. The methods of water treatment include the following:

    a. Sedimentation is used to remove suspended matter.

    b. Coagulation is used to collect the non-settleable particles into larger aggregates which can be readily removed.

    c. Filtration is passing water through sand or other fine grained material to remove particulate matter which coagulation did not remove.

    d. Disinfection is the destroying of pathogenic organisms usually by the application of chlorine or chlorine compounds.

    e. Softening is the removal of calcium, magnesium and other elements which contribute to hardness of a water supply.

    f. Aeration is used for a variety of purposes which include:

        (1) Taste and odor control
        (2) Removal of carbon dioxide
        (3) Aid in iron removal

    g. Fluoridation is added to water to provide maximum resistance to tooth decay.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Using a microscope, examine samples of water, make drawings, and try to identify many of the microorganisms found there.

2. Collect a sample of turbid water and, using a Jackson Candle, determine the amount of turbidity in it.

   Procedure:

   The Jackson Candle consists of a stand which holds a candle and a graduated tube. Use a darkened room and, with the candle lit, slowly add water until the turbidity of the water blocks the light of the flame from passing up through the tube. Record the turbidity reading from the tube given at the top of the water column.

3. Evaporate a sample of turbid water after it has been weighed and determine the percentage of solids. Since, on the average, a person uses about 20,000 gallons of water per year, how many pounds of solids would have to be removed from the water?

4. Visit a water treatment plant and ask the chemist to explain several of the more common water quality tests performed by him. If possible, have him assist the students in doing one or two tests that an operator must perform.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his awareness of important characteristics to consider in terms of the quality of water through a written test and by performing the water quality test to determine the presence of specific substances in a given water sample. Sample evaluations to be used could include:

1. What all water-born diseases have in common

2. Why coliform organisms are called indicator organisms

3. The important safeguards in collecting a sample for bacteriological analysis

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Microscope - 10-20X eyepiece, 40-100X objective

2. Jackson Candle

3. Oven or other heat source to evaporate water

4. Analytical balance, capacity 200 grams, sensitivity to 0.1 mg.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 99-114.

   A discussion is presented on the three reasons for water treatment and how an operator can be sure that the quality of his product is maintained. The revised standards for the quality of drinking water is provided as well as examples of impurities which water from different sources may carry.

2. Water Works Operation. Unit II. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 7-12.

   An important point in this reference is that even though the physical and chemical characteristics of a water supply may be satisfactory, the bacteriological purity of that water must also be checked. Safe water cannot contain any organism that would indicate the presence of disease bacteria. For this reason the water must be tested regularly to determine its bacteriological quality using the presumptive and the confirmed tests.

CHLORINATION

UNIT CONCEPT: Finished water may be clear, soft and free of tastes and odors, but if it has not been properly disinfected it may not be safe for human consumption.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain the importance of the use of chlorination in public water supplies.
2. Explain the proper method of detecting chlorine leaks.
3. Use a chlorine gas mask in a manner that would prevent personal harm from the fumes.
4. Determine the maximum chlorine available per day from a given number of cylinders of a specific size.
5. List the seven factors which influence chlorination and explain their effect.
6. Describe the reaction stages of chlorine as it is added to water.
7. Describe how the chlorinator room should be ventilated.

B. INSTRUCTIONAL AREAS

1. Gaseous chlorination - chlorine is stored as a liquid by keeping it under pressure. But at normal temperatures and pressure, chlorine is a gas and in this form it is mixed with water as a disinfectant.
2. Hypochlorination - compounds of chlorine such as sodium or calcium hypochlorite are added to water and used in a solution form as a disinfectant.
3. The practice of chlorination - for the treatment to be successful, the chlorine must:

   a. Be mixed thoroughly with all the water to be treated
   b. Have continuous mixing
   c. Be added in large enough amounts to accomplish the treatment desired

4. Reaction of chlorine in water
   a. Chlorine reacts first with reducing compounds such as iron and nitrites and results in no disinfection.
   b. If more than enough chlorine is present for the first reaction, then the extra chlorine reacts with organic matter but still does not have disinfection action.
   c. Additional chlorine not needed in the first two reactions will react with any ammonia present and serves as a weak disinfectant.
   d. Chlorine added beyond the amounts needed in the previous reactions will be free and very active as a disinfecting agent.

5. Factors influencing chlorination
   a. Time concentration
   b. Temperature
   c. pH

6. Chlorination techniques
   a. Pre-chlorination
   b. Post-chlorination
   c. Super-chlorination
   d. Dechlorination
   e. Breakpoint chlorination
   f. Free residual chlorination

7. Advantages of free residual chlorination
    a. Contact time required for disinfection to occur is reduced.
    b. No change in the chlorine residual is needed within a pH range of 6.0 to 8.0.
    c. A change in temperature does not affect the amount of chlorine residual required.
    d. With the use of the chlorine residual, tastes and odors are more acceptable.
    e. The free chlorine residual is persistent and can be maintained in the distribution system.
8. Chlorine hazards - chlorine gas is very toxic and corrosive in a moist atmosphere. A small amount will cause an individual to cough severely and heavy exposure can be fatal.
9. Operation and maintenance of chlorinators
    a. Types of equipment
    b. Types of controls for chlorinators
    c. Selection of the point for chlorination
    d. Installation features to consider
    e. Continuity of chlorination
    f. Chlorine containers
    g. Safety precautions
    h. First aid for chlorine inhalation

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Since chlorine is a dangerous chemical, it is important to know how to protect oneself from the hazardous fumes. Instruction is needed in the use of a self-contained breathing apparatus and with

regular practice it can become routine. The fire department can be helpful in providing such training.

2. With the help of the high school chemistry instructor, prepare a small amount of chlorine in the laboratory by using manganese dioxide and hydrochloric acid. Allow a small amount to escape in the presence of ammonia and notice the reaction. **Be careful not to breathe any of the chlorine. **White fumes should result when the two chemicals come into contact. This is why ammonia is used in locating chlorine leaks in a water treatment plant.

3. Determine the answers to similar problems like the examples found on pages 81 and 82, "Texas Manual," Unit IV.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

Have each student demonstrate his knowledge of the importance of chlorine and how it is used in the public water supply. He must be able to describe the hazards of chlorine, detect chlorine leaks, and demonstrate the proper use of a self-contained breathing apparatus.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. A self-contained breathing apparatus

2. A good chemistry laboratory - manganese dioxide, hydrochloric acid, ammonia

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 10-33 - 10-38.[3]

   More detail is provided on the hazards to consider in using chlorine. Recommendations are provided on how to protect oneself and what first aid measures are needed.

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[3] This manual will be referred to, in text, in the following units as the "Sacramento Manual."

2. Water Works Operation. Unit I. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 13-16.

   This reference considers the methods of application of chlorine, determination of required dosage, maintenance and safety of equipment as well as proper first aid.

3. Water Works Operation. Unit IV. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 81-82.

   Examples of chemical dosage problems are given in this source.

CHEMICAL COAGULATION

UNIT CONCEPT: Use of a chemical to coagulate fine particles will cause them to join together and settle out to clarify the water.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain the process of chemical coagulation.
2. List the three steps in coagulation and flocculation.
3. Identify the most common chemical used for coagulation.
4. Perform the "jar test."
5. Demonstrate the effect of pH on coagulations.
6. Discuss the factors which influence coagulation.

B. INSTRUCTIONAL AREAS

1. Chemical coagulation - the process consists of the following steps:
    a. Feed one or more chemicals into the water.

    b. Mix to distribute the chemicals rapidly and evenly in all parts of the water.

    c. A chemical reaction occurs and floc is formed by the coagulation.

    d. Gentle agitation is given to the treated water for a period of time to allow the small floc particles to combine which is called flocculation.

2. Chemicals used for coagulation - this is dependent on the characteristics of the water to be treated. A combination of two chemicals may produce better results than any one chemical alone.

a. Aluminum sulfate (alum) is most commonly used.

b. Sodium aluminate is used with alum when alkalinity is necessary.

c. Iron salts such as ferric sulfate, ferric chloride, ferrous sulfate and chlorinated copperas are used if the conditions are too acid for good results with alum.

d. Coagulant aids such as lime, sodium carbonate, sodium hydroxide and sulfuric acid are used to adjust the pH of the water for the best coagulation. Other coagulate aids such as clay, sodium silicate, and activated silica are used to provide solid surfaces needed to begin floc formation. Synthetic polymers may be used to react with the fine particles to bring them together to be a large enough mass to settle out.

3. Chemical application - the most commonly used water coagulant, aluminum sulfate (alum), can be in granular powder-like form which is readily soluble in water and is easily applied as a dry material or it may be in liquid form. Machines can be calibrated to deliver a known amount of alum during a certain period of time. Some machines feed alum in a dry form and others use the solution form.

4. Jar test - a laboratory stirring apparatus is necessary to secure definite results in determining the amount and type of coagulant needed for use with different samples of water. Stock solutions of coagulants are prepared and used in varying concentrations with one liter of water in making this determination.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. The students should conduct an experiment to determine the required amount of coagulant needed to remove the turbidity in the water collected from various sources. First, prepare a stock solution using 17.1 grams of alum per liter of solution. Using a variable speed jar test apparatus with four stations, add varying amounts of the stock solution and determine its effectiveness for different time periods and different speeds. Refer to the jar test in the "Texas Manual," Unit IV, pages 16-17.

2. Change the chemical or use a combination of chemicals and compare the results with the amount of alum alone required.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

Have each student determine the least amount of alum needed to remove the turbidity from a given sample of water in a stated length of time. He also must demonstrate that he is aware of the factors which influence coagulation and an understanding of the process.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. A Phipps Byrd variable speed jar test apparatus with four stations
2. A stock solution of 17.7 grams/liter of alum and other chemicals desired

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 115-121.

   This reference provides a discussion relating to the fact that with chemical coagulation, water is treated with chemicals to cause the non-settleable particles to come together into larger, heavier masses of solid material called floc. There are a number of chemicals which can be used for coagulation and a number of ways in which they may be applied to the water.

2. Water Works Operation. Unit IV. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 11-21, 75-77 and 81.

   A good discussion is provided in this reference on the equipment used in coagulation and how it works. The use of the jar test is also very well explained. The appendix provides examples of mathematics problems which the students must understand and be able to calculate.

SEDIMENTATION

UNIT CONCEPT: Decreasing the velocity of water flow will lessen the ability of the water to hold particles in suspension and provide a means to remove them from the water.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain the purpose of sedimentation.
2. Describe the type of structure which is needed for sedimentation.
3. Determine the detention time of a given size basin with a given rate of flow.
4. Demonstrate the ability to solve correctly mathematics problems relating to volume, velocity and converting gallons per minute to gallons per day.
5. Demonstrate a procedure for detecting "short-circuiting" and describe the corrective measures.
6. Describe the various methods of sludge disposal from the sedimentation basins.

B. INSTRUCTIONAL AREAS

1. Sedimentation - Settlement of particles in quiescent water depends on size, shape, and specific gravity of particles as well as the temperature of the water.
2. Types of sedimentation
    a. Plain sedimentation - a large basin for low velocity water flow
    b. Coagulating reservoirs - a basin to allow settling following coagulation

   c. Sludge blanket type sedimentation - a basin which uses the principle of upward flow for clarification

3. Detention and rate of flow - four to six hours of detention is required to prevent excessive floc from being carried to the filters.

4. Design of the basin

   a. Two or more units are used which allows one to be taken out of service without shutting down the operation.

   b. Inlets must be constructed so that deposited sludge is disturbed as little as possible.

   c. The outlet of the basin should be constructed to remove sludge by a long wire extending across the basin.

   d. Mechanical sludge removal allows greater capacity and lower velocities of flow.

   e. A short straight path from the coagulating basin to the filters is most desirable.

5. Short circuiting - a change from the designed flow of water

   a. A method of detection is the use of a dye such as uranin.

   b. Remedies include influent launders, baffles, and orifice walls.

6. Sludge and its disposal

   a. In conventional basins, wastes follow the sloping floor by gravity and are flushed by a high pressure hose.

   b. In the clarifier type, a spiral rake is slowly pulled over the bottom to work the sludge to a central sump for removal.

   c. With a sludge blanket, the sludge is collected in concentrators where sludge is drawn off automatically.

   d. Methods of sludge disposal include lagooning, liming for farmers, dewatering by filtration, and burning to recover lime.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. It is important for the student to understand the determination of water volume, velocity, detention time, and conversion of quantities. Examples of such problems are found on page 79 of the "Texas Manual," Unit IV.

2. The student will assist an operator in checking the flow in a sedimentation basin using the plant's method of detection.

3. Visit a treatment plant in the area and prepare a report on the type of sedimentation facilities and equipment, and how it functions.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must know how to determine the volume of a sedimentation tank, the velocity of the water flowing through the tank, the detention time of the tank, and how to convert a flow in gallons per minute to gallons per day. The student should also demonstrate a good understanding of the operation of a sedimentation basin and the principles relating to the design of such a basin.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A visit to water treatment plants in the area would be helpful to see the different types of sedimentation facilities and equipment in use.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 123-125.

   A short presentation is made concerning sedimentation, the operation of the tank and the advantages of having mechanical removal of the sludge.

2. Water Works Operation. Unit IV. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 23-27, 79.

   This unit considers the fact that sedimentation is the process in which the coarse particles are allowed to settle out from suspension as the water velocity is slowed. There are a few types of sedimentation which have different detention times and rates of flow. In the design and operation of the basin, it is important to prevent short circuiting and provide for a method of sludge removal.

FILTRATION

UNIT CONCEPT: Filtration is a process of passing water through sand or similar material. This plays an important part in producing sparkling clear water by removing fine inorganic or organic materials, and, in the process, may reduce bacteria content and the contaminants which cause taste and odor.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Determine the size (L X W) of a rapid sand filter which treats 2 gals./sq. ft./min. in a water plant for a given number of gallons of water in a twenty-four hour day.

2. Identify the conditions of loss-of-head by use of "Loss-of-Head Gauges" in time to start washing procedures according to plant standards.

3. Explain the differences in filter media, sand and anthrafilt, and define the advantages and disadvantages of each to the satisfaction of the plant operator.

4. Describe the function of a rate of flow controller, where it is located, and how it is used to determine water flow through the filter.

5. Determine when a filter should be washed according to amount of head loss or when the effluent is no longer satisfactory.

6. When filter washing is to be done, wash the filter with the assistance of the operator, until wash water rinsing through the filter is clear.

7. When a filter is not functioning properly, identify and assist the operator in correcting such problems as:

   a. Mud balls

   b. Uneven wash

   c. Cracks in the sand

   d. Clogging

   e. Algae and bacteria growth

B. INSTRUCTIONAL AREAS

1. Filter construction

   a. Filter box - a square or rectangular concrete box with vertical walls open at the top and 10 or more feet deep.

   b. Wash water troughs - steel or concrete troughs used to collect the up-flowing wash water

   c. Inlet and outlet - inlet lines must be of ample size to keep velocities low. The outlet line must be large enough to carry away the filtered water and provide uniform delivery of the wash water.

   d. Under drains are needed to collect the filtered water and also to deliver the backwash water.

   e. Valves - hand operated gate valves are used in small plants; hydraulic cylinders are used in the larger plants to operate the valves.

2. Loss-of-head is a drop in pressure at the bottom of the filter bed due to increases in floc and mud accumulation on the filter surface.

3. Loss-of-head gauge is a tube of mercury connected to the water above the sand and to the effluent pipe so that a pressure difference between the two heads will be indicated by the mercury level.

4. Rate of filtration and rate controllers - the rate of filtration of a rapid sand filter is two gallons per square foot per minute; this rate is kept constant by a rate controller. After the filter has been washed, the controller slows the water down; as the sand becomes clogged, the controller enlarges the opening to maintain a constant flow.

5. Pressure filters - cylindrical steel tanks enclose rapid sand filters

through which water passes under pressure. The rate of filtration is five gallons per minute per square foot of filter area which is considerably greater than the filtration rate of the rapid sand filter method.

6. Filter media

   a. A sand bed having a depth of 26" to 30" is the heart of the filter unit. The size of the sand is very important and should be free of dirt and flat grains.

   b. Anthrafilt which is anthracite coal is competitive with sand for filter media. The advantages are higher filtration rates, longer filter runs, and less coating of grains with lime and other materials. A disadvantage is that the wash rates must be carefully controlled to prevent the coal from floating over the troughs.

   c. Gravel acts as a support for sand and helps to distribute the wash water uniformly from the under drains. Usually 16" to 18" of gravel are used in three to five different sized layers with the largest size on the bottom.

7. Care of filter beds

   a. Inspection of a filter should be during each wash to detect uneven wash, mud balls, mud or silt on the filter after the wash, air in the filter, and cracks.

   b. Proper washing is important for good filter operation; there must be uniform distribution of the wash water with agitation of the sand for efficiency in washing.

   c. Skimming is the physical removal of the top crust of sand from a filter.

   d. Algae and bacteria - algae growth on troughs and walls should be kept to a minimum by hosing and the use of copper sulfate. Bacteria in the filter sand can be determined by comparing a plate count of the filter effluent with the filter influent. If bacteria are found to be growing in the filter, it must be taken out of service and chlorinated.

8. Filter washing

a. When to wash

(1) As soon as suspended material begins to pass through sand beds
(2) Loss-of-head is used by some plants to determine when to backwash the filter. This loss may range from 6 to 8 feet.
(3) Controller in the wide open position is an indicator if a loss-of-head gauge isn't available.
(4) Part time operation of a filter requires the filter to be washed at least once every day.
(5) Length of filter runs should not exceed the maximum permissible loss-of-head since filtering efficiency is lost and wash water requirements are increased.

b. How to wash

c. Rate of backwash

(1) Eight times the normal filtration rate is needed to achieve a 50% bed expansion.
(2) Four to 6 minutes is usually required to produce a clear wash water.
(3) Not more than 2.5% of the water filtered should be used to wash the filter.

d. Equipment used to assist filter washing includes:

(1) Surface wash systems
(2) Air wash
(3) Mechanical rakes

9. Filter troubles

a. Mud balls are the biggest problem in filters and are prevented by proper coagulation and sedimentation and proper backwash rates.

b. Cracks in the sand are caused by a coating of gelatinous material on the sand which causes the sand to shrink. Also, high rates of filtration cause the sand to pull away from the walls. These cracks may be one inch wide and 12" to 18" deep, thus reducing the filtering efficiency.

c. Clogging is the formation of large masses of mud which prevent the flow of water through the sand. This produces uneven loading, shorter runs, and an inferior effluent.

d. Mounds and craters are caused by damage to the under drain system or mud deposits on the surface of the gravel.

e. Jet action is a lack of uniformity in the upward flow of water caused by mud deposits on top of the gravel or problems in the under drain system which causes the sand to boil, a mixing of fine gravel and sand, and accelerated clogging at the surface of the gravel.

10. Cleaning filter sand

    a. Caustic soda is used to clean the filter sand if the materials are organic or alum deposits.

    b. Chlorine is another chemical used to remove organic matter from the sand grains.

    c. Hydrochloric or carbonic acid is used in softening plants to remove deposits of calcium carbonate.

    d. Sulphur dioxide is used to dissolve coatings of manganese, iron, and calcium carbonate.

    e. Copper sulphate is used to control the growth of green algae on filter walls.

    f. Sodium hexametaphosphate (calgon) is used in softening plants to keep iron and calcium in solution.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. The student should build a scale model filter using a large clear plastic cylinder and providing: an under drain, a method of backwashing, and a filter media.

2. The student should ask permission to assist the water treatment operator a number of times in backwashing a filter after having observed how it is performed, and be able to verbally go through the steps involved.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. The student must demonstrate his knowledge of water filtration in a written test with respect to filter construction, operation, problems, and maintenance.

2. The student must also demonstrate the proper washing of filters while under the supervision of a plant operator.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Large clear plastic cylinder, filter media and fittings to build model filter

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 127-151.

   Much the same material is covered in this reference as in the "Texas Manual," but in greater detail.

2. Water Works Operation. Unit IV. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 29-47.

   This reference considers the process of filtration, filter construction, head loss, pressure filters, filter media, care, and problems.

WATER SOFTENING

UNIT CONCEPT: Water softening is used to remove dissolved minerals by chemical precipitation or ion exchange to improve taste, algae control, clarification, and reduce the amount of soap required to produce a lather.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Identify the two types of hardness which are removed by softening and the chemical needed for their removal, to the satisfaction of the instructor.
2. When given the list of chemicals and chemical formulas in a jumbled order, accurately match the name of the chemicals that cause hardness with the correct chemical formula.
3. Describe the difference between hydrated lime and quicklime to the satisfaction of the instructor.
4. Determine the correct amount of lime soda needed to soften a sample of water by using the jar test.
5. Perform a pH test, phenolphthalein and methyl orange alkalinity tests according to plant test standards.

B. INSTRUCTIONAL AREAS

1. Types and causes of hardness
    - a. Carbonate hardness - calcium or magnesium bicarbonate
    - b. Noncarbonate hardness - calcium and/or magnesium with ClO, SO_4 and NO_3
2. Softening processes - lime soda is used to precipitate and remove magnesium, carbon dioxide, and carbonate hardness in water.

a. Dosage determination

(1) 0.0743 grains of CaO (100% quicklime) per gallon for each part per million (ppm) of free carbon dioxide
(2) 0.0327 grains of CaO per gallon for each ppm of alkalinity (as $CaCO_3$)
(3) 0.0618 grains of soda ash per gallon for each ppm of noncarbonate hardness
(4) 0.1345 grains of CaO per gallon for each ppm of magnesium (as Mg)

b. Application of chemicals

(1) Hydrated lime is dry fed through machines since water is present in the compound.
(2) Quicklime must have water added to form a milk of lime solution before being added to water. This is called slaking in which 4 or 5 pounds of water are added to one pound of quicklime. The temperature should be maintained between 107° and 180° F. with a 30 minute detention time.
(3) Soda ash may be fed as a solution but the dry form is preferable.

c. Control of chemical treatment - jar tests are required for control of lime softened waters for pH, hardness, and both phenolphthalein and methyl orange alkalinity. A pH of 9.4 is required when only calcium is removed. The pH must be 10.6 to remove magnesium.

d. Advantages of the lime-soda process

(1) Process most suited for waters high in carbonate hardness
(2) One pound of quicklime ($CaCO_3$) removes 1.5-3 pounds of solids
(3) Efficiency of coagulation is increased.
(4) Bacteria is reduced.
(5) Less corrosion
(6) Iron and manganese are removed.
(7) Low cost

e. Disadvantages of lime-soda process

(1) Reduce hardness only to 30-40 ppm

(2) High concentration of sodium salts
(3) Large amounts of sludge must be disposed of properly.
(4) Close supervision is required.
(5) Necessity of recarbonation of stabilization of finished water to prevent deposits of calcium carbonate

3. Sodium zeolite softening

a. Sodium zeolite ions replace calcium and magnesium to soften the water.

(1) Natural zeolite or greensand removes 2,500 to 5,000 grains of hardness per cubic foot of material
(2) Synthetic sodium zeolites remove 6,000 to 12,000 grains of hardness per cubic foot of material.

b. Strong salt brine solutions are used to regenerate the zeolite that has lost its sodium ions (3.5 pounds of salt is needed for each pound of hardness removed).

c. A zeolite softener is similar to a sand filter with zeolite instead of sand, and filters at a rate of 5 gallons per square foot of zeolite per minute.

d. Control of the zeolite process - When there is an increase in hardness above zero in the water effluent the unit must be regenerated with a salt solution. Hardness is determined by the soap hardness test or the versenate hardness method.

e. Advantages of the sodium zeolite process

(1) All hardness is removed.
(2) Simple operation
(3) No sludge is produced.
(4) No stirring equipment is used.
(5) More economical in the removal of noncarbonate hardness than is soda ash.

f. Disadvantages of the sodium zeolite process

(1) The sodium content of the water is increased.
(2) Raw water must not contain turbidity or iron.
(3) High percentage of wash water is required for regenerating.
(4) Water must be further treated to stop corrosiveness.
(5) pH must be between 7.0 and 8.3.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Using the soap test, determine the amount of hardness of water from several sources.

Procedure:

a. Fill burette to 50 ml. mark with the standard soap solution.

b. Measure 50 ml. of sample water, using volumetric flask, and transfer it to a 250 ml. glass-stoppered bottle.

c. Add the standard soap solution from the burette in amounts of less that 0.5 ml. to bottle of sample water. Shake vigorously twenty-five times after each addition of standard soap solution. As the end point of titration is approached, the volume of solution added should be reduced.

d. To observe the lather, lay the bottle on its side.

e. Continue adding the standard soap solution until the lather persists at least 5 minutes on the water surface.

f. The burette is then read to determine the amount of standard soap which has been used. To be sure that the end point was reached, add an additional 0.5 ml. of soap solution, shake and check to see that the lather lasts 5 minutes. If it does not, then you reached a "ghost" end point rather than a real one previously. You should then continue the titration as above until the true end point is reached.

g. Subtract the amount of soap used to produce lather (lather factor is usually 0.3 ml.) from the total amount of soap solution which was used. The lather factor can be found on the label. This is done because water with zero hardness requires a certain amount of soap to produce lather.

h. Multiply the corrected amount of soap solution by twenty to determine hardness in ppm (parts per million).

i. If more than 7 ml. of the standard soap solution is needed, the test should be repeated using 25 ml. of sample water diluted with 25 ml. of distilled water.

Results:

Hardness is reported as part per million calcium carbonate, regardless of whether it is calcium or magnesium or both.

Hardness ($CaCO_3$) =

$$\text{(ml. soap solution - lather factor)} \times 20 \times \frac{\text{50 ml.}}{\text{ml. of sample}}$$

Interpretation:

a. Water for home and laundry should contain less than 100 ppm of hardness.

b. Water with over 300 ppm of hardness is not suitable for ordinary use.

c. Water with less than 30 ppm is corrosive and must have lime added to increase hardness.

2. The jar test using lime soda could be used as suggested in Chemical Coagulation, Unit IV of the "Texas Manual," but to soften the water. The soap test could be used to determine the hardness of the water before and after the jar test.

3. The pH test, phenolphthalein, and methyl orange alkalinity tests should all be familiar to the student. The directions for such tests are enclosed with the reagents by the manufacturer.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to determine the hardness and pH of water. He must also demonstrate the use of the reagents phenolphthalein and methyl orange. He should know the types of hardness, chemical names and formulas related to hardness and be able to determine the amount of chemical needed when given the raw water analysis.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Soap test: 50 ml. burette; burette stand; 250 ml. glass-stoppered bottles; standard soap solution; 50 ml. volumetric flask

2. Jar test: Phipps Byrd variable speed jar test apparatus with four stations; lime soda

3. Reagents for tests of: pH; phenolphthalein ; and methyl orange

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 171-178.

   Much the same information is presented in the "Texas Manual," but it would be helpful to check the mathematical examples on pages 172 and 177-178 of this reference.

2. Water Works Operation. Unit IV. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 49-57.

   A discussion is presented on the reasons for water softening, types and causes of hardness, types of softening processes - lime soda and sodium zeolite and other less common processes.

AERATION

UNIT CONCEPT: Taste and odor of water can be controlled by bringing it into intimate contact with air to change the concentration of volatile substances and gases contained in the water.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Accurately identify the volatile substances which are decreased and those which are increased in concentration as a result of aeration.
2. List several limitations of aeration, tothe satisfaction of the instructor.
3. Name three types of aerators and explain the operation of each, to the satisfaction of the instructor.
4. Demonstrate the ability to determine the oxygen and carbon dioxide content of water well enough to meet or exceed plant standards for these tasks.

B. INSTRUCTIONAL AREAS

1. The purpose of aeration is to improve the physical and chemical characteristics of water.
   - a. Aeration decreases:
     - (1) Substances that produce tastes and odors such as organic compounds
     - (2) Substances that increase the corrosive action of water such as carbon dioxide, hydrogen sulfide
     - (3) Substances that interfere with water treatment chemicals such as carbon dioxide and hydrogen sulfide
     - (4) Miscellaneous gases such as methane
   - b. Aeration increases:

  - (1) Oxygen which improves taste and assists in the oxidation of materials
  - (2) Carbon dioxide can be added instead of oxygen to neutralize causticity.

2. Limitations

   a. Not an efficient method to remove tastes and odors when substances are not volatile

   b. With organic matter present, aeration alone cannot precipitate iron and manganese.

   c. Carbon dioxide content of water cannot be reduced to zero because of its presence in air but can be reduced to the same level as found in air.

   d. No direct effect on bacteria or other microorganisms

3. Types

   a. Waterfall aerators - expose water films to air by spreading water as much as possible and allowing it to flow over obstructions which produce turbulence, as with a concrete step structure. This removes 20-45% of the carbon dioxide.

   b. Spray aerators force water into the air from fixed nozzles resulting in 70-80% removal of carbon dioxide.

   c. Diffused-air type introduces air into water in the form of small bubbles.

4. Operation

   a. Freezing temperatures during winter cause problems if the operation is unhoused.

   b. An enclosed aerator must be ventilated for efficiency and safety.

   c. Materials which resist the action of water must be used in the structure and equipment.

   d. Slime and algae on waterfall aerators are controlled by chlorine or copper sulfate.

5. Laboratory control

   a. Measure the increase in concentration of oxygen; it should be 50% saturation.

   b. Hydrogen sulfide should be eliminated completely.

   c. Carbon dioxide should be at 5-10 ppm.

   d. Tastes and odors should be reduced by 50%.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

Collect samples of water from different sources such as streams and reservoirs. Determine the oxygen and carbon dioxide content of this water. Slowly place this water into aquariums and connect to an air pump. Over a period of several intervals in time, samples can be examined for O_2 and CO_2 to determine change.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

With a paper and pencil test or by verbal description, the student must identify those gases that are either added or removed by aeration, the limitations of aeration, and identify three types of aerators, explaining the operation of each. He must also demonstrate an ability to determine the oxygen and carbon dioxide content of water.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. One or more 10-gallon aquariums plus an aquarium pump
2. Water samples collected from various sources
3. Testing equipment is needed with the reagents for determining oxygen and carbon dioxide.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 179-183.

A short presentation of the process of aeration is provided which includes the purpose, limitations, types of aerators, their operation, and the laboratory control of aeration.

PUMPS AND PUMPING

UNIT CONCEPT: Pumps are needed to transport water, overcome the force of gravity, and to provide the desired pressure to the supply of water.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. List the advantages and disadvantages of centrifugal pumps in regard to selection for a plant operation.
2. List the advantages and disadvantages of displacement pumps in regard to selection for a plant operation.
3. List three methods which may be used to determine the output of a pump. These should include:
    a. Meter measurement of discharge
    b. Calculating discharge into a tank in a given time
    c. Use of a pitot tube
4. Identify the six major pump problems and define two or more causes for each.
5. Explain why displacement pumps are not more widely used in water works installations.
6. Demonstrate the proper procedure for packing a pump.
7. List three or more important considerations in the installation of a pump.
8. Distinguish among the following:
    a. Static head
    b. Friction head
    c. Velocity head

B. INSTRUCTIONAL AREAS

1. Types of pumps
    a. Centrifugal pumps
        (1) Single stage or multistage
        (2) Volute type
        (3) Turbine type
    b. Displacement pumps
        (1) Direct-acting steam pump
        (2) Crank and flywheel pumps
        (3) Reciprocating pumps powered by an outside source
        (4) Rotary displacement pump
2. Maintenance of pumps
    a. Lubrication and packing
    b. Alignment and foundation
    c. Foreign matter
    d. Low head
    e. Pump sanitation
3. Valves
    a. Gate valves
    b. Check valves
    c. Foot valves
4. Electric motors
    a. Squirrel cage induction motor
    b. Synchronous motors
5. Pump troubles

   - a. No water delivered
   - b. Not enough water delivered
   - c. Not enough pressure
   - d. Pump works for a period of time and quits
   - e. Pump takes too much power
   - f. Pump noises

6. Pump computations
   - a. Static head
   - b. Friction head
   - c. Velocity head
   - d. Water horsepower
   - e. Brake horsepower
   - f. Electrical horsepower
   - g. Efficiency
   - h. Kilowatts
   - i. Tank volume

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Each student should disassemble a centrifugal pump, clean it, identify the parts by name, repack the glands, reassemble the pump and check it for proper operation and output.

2. Each student should disassemble an electric motor, clean it, identify the parts by name, lubricate it properly, reassemble it, and check it for proper operation.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate a knowledge of different types of pumps, their advantages and disadvantages, where they are used, determination of pump output, and how to determine the static head, friction head, and velocity head of water. He must also demonstrate the ability to disassemble, pack a pump, and explain procedures necessary for proper installation and alignment.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Shop area
2. Hand tools
3. Centrifugal pumps
4. Electric motors

F. EXAMPLES OF SUPPORTING REFERENCES

1. Water Works Operation. Unit I. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 37-44.

   A brief description is provided on the types of pumps, their maintenance, and pump troubles.

2. Water Works Operation. Unit II. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 49-55.

   Pumps and motors are described in greater detail in this reference.

3. Water Works Operation. Unit III. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 37-46.

   This unit is concerned with the use of pumps and motors for well water. Some very good mathematical exercises are provided which relate to the pumping of water.

WATER STORAGE

UNIT CONCEPT: Due to fluctuations in demand for water and to permit the production facilities to operate at a uniform rate, storage of treated water is needed.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain the purpose of water storage facilities in terms of water reserves.
2. Determine the rate of flow in cubic feet per second (cfs) and gallons per minute when given a flow rate in feet per second of a specified size main.
3. List the considerations for sanitary protection of storage reservoirs.
4. List the advantages of elevated storage as compared to ground storage.
5. Explain what maintenance is necessary with storage tanks.

B. INSTRUCTIONAL AREAS

1. Purpose of storage
2. Ground level storage
    a. Location
    b. Construction features
    c. Sanitary protection
3. Elevated storage
    a. Purpose

b. Advantages

c. Location

d. Maintenance

e. Sanitary protection

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. It is important that the student has a good understanding of mathematics concepts. Develop problems similar to the examples at the end of Unit I, "Texas Manual." Mathematics is given considerable importance on the Water Treatment Exam.

2. Visit the water storage facilities in the area and discuss the selection and maintenance of the facilities.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his knowledge of determining tank capacity, velocity of flow, and dosage of chemicals needed for water treatment. He must also know the types of storage, their maintenance, and their advantages. Sample test items might include:

1. Describe the sanitary protection that should be given a ground level storage tank.

2. A circular tank has a diameter of 50 feet and is 10 feet deep. Calculate the capacity of the tank in gallons.

3. The overflow pipe of an elevated storage tank is 127 feet above the center line of a pump boosting water into it. How many pounds per square inch (psi) would be required to overflow the tank?

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Water storage facilities in the area

F. EXAMPLES OF SUPPORTING REFERENCES

1. Water Works Operation. Unit I. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 33-36, and 57-60.

   A brief discussion is presented on types of water storage, their construction, maintenance and sanitation. Further information is provided at the end of the unit related to terms, equivalents, and mathematics problems.

WATER DISTRIBUTION

UNIT CONCEPT: The water must be delivered to the consumer in as safe a condition as when it left the treatment plant.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Locate valves easily and prevent excessive customer service disruption during breaks and repairs.
2. Identify the commonly used pipe for water mains and service lines, to the satisfaction of the instructor.
3. Explain the cause of corrosion in a distribution system and how this corrosion can be controlled, to the satisfaction of the instructor.
4. Identify the sources of sanitary hazards in a distribution system.
5. Describe considerations in design and construction of a distribution system to meet adequate and efficient distribution standards. Include:
    a. Sanitary safety
    b. Carrying capacity and pressures
    c. Location of valves and hydrants
    d. Location with reference to storage
6. Collect a water sample from the distribution system representative of the quality of water in the system.

B. INSTRUCTIONAL AREAS

1. Considerations in distribution line extensions
    a. Sanitary safety

- b. Carrying capacity and pressures
- c. Location of valves and hydrants
- d. Location with reference to elevated storage

2. Pipe used for water mains
   - a. Cast iron
   - b. Steel pipe
   - c. Reinforced concrete
   - d. Asbestos cement
3. Pipe used for service lines
   - a. Galvanized steel
   - b. Copper tubing
   - c. Lead service
   - d. Cast iron
   - e. Plastic pipe
4. Joints and joint material
   - a. Bell-and-spigot
   - b. Cement
   - c. Packing
   - d. Mechanical joints
   - e. Sleeves
5. Corrosion and its prevention
   - a. Dissolved oxygen
   - b. Carbon dioxide

    c. Hydrogen sulfide
    d. Electrolysis
    e. Galvanic

6. Sanitary hazards in a distribution system
    a. Cross-connections
    b. Line location
    c. Water storage
    d. Line sterilization
7. Valves
    a. Gate valves
    b. Check valves
    c. Packing
8. Hydrants
9. Water meters

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. The student should spend some time with men working in the construction or maintenance of the distribution system. He should note specifically the care used to avoid contamination to the line.

2. The student should learn how to properly collect samples in the distribution system for laboratory analysis. He should then ask for the responsibility of periodically collecting water samples from a specific area to test under the supervision of his instructor in school or the laboratory technician at the water treatment plant. The procedure for the "membrane filter technique" is given on pages 296-298 of the "New York Manual."

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

By essay-type evaluation, the student should describe the consideration which must be given to good design and construction of distribution lines. He should identify the types of pipes which are used and explain the causes of corrosion and how it can be controlled. The student must also demonstrate his ability to identify the proper sanitary precautions needed in a water distribution system. He must demonstrate the correct procedure for collecting a water sample from the distribution system.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Autoclave which operates at 15 lb. pressure and 121° C.
2. 10% solution of sodium thiosulfate
3. Several 250 milliliter sterilized collection bottles containing one milliliter of a 10% sodium thiosulfate solution (added before sterilization)
4. Incubator which can maintain a constant temperature between 34° and 36° C. in the incubation chamber
5. Milk dilution bottles, Pyrex with rubber stoppers
6. Low-power microscope for 10-15X magnification
7. Presterilized plastic petri dishes, 60 mm. diameter, 15 mm. depth
8. Filter holding assembly
9. Pyrex vacuum flask, 1,000 ml.
10. Vacuum source
11. Stainless steel forceps, smooth inner surface, round-tipped
12. Filter membranes, 47 mm. in diameter with grid marks
13. Absorbent pads, 47 mm. in diameter
14. Dehydrated MF - Endo Broth
15. Buffered dilution water

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 217-221, 296-298.

   The suggestion is made that the delivery of safe water is dependent on the protection given to the water by the distribution system. Topics covered in this reference include the design and construction of distribution systems, operation and maintenance of distribution systems, and monitoring water quality.

2. Water Works Operation. Unit I. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 45-53.

   The emphasis of this reference is on safeguarding the quality of water through proper sanitation in the construction and maintenance of water lines.

3. Water Works Operation. Unit II. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 39-47.

   This reference describes the materials considerations for a water distribution system. This includes considerations for distribution line extensions, pipes for mains and service lines, joints and joint material, valves, hydrants, and water meters.

FLOW MEASUREMENT

UNIT CONCEPT: The water treatment operator must calculate flow rates to enable him to determine the amount of chemicals needed for the proper treatment of water.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain why flow measurement is necessary in a water treatment plant, to the satisfaction of the instructor.

2. List three types of measuring devices which are representative of those used in treatment plants.

3. Determine accurately the rate of flow in cubic feet per minute when provided with the size of the channel and the velocity of the water in feet per second.

4. Determine accurately the rate of flow in gallons per minute of water when the size of the pipe and the rate of flow in feet per second is provided.

B. INSTRUCTIONAL AREAS

1. Units used in measuring the quantity of water flowing in a given time:

    a. Head - the amount of energy possessed by a unit quantity of water at its given location

    b. Elevation or static head - the vertical distance from some base level

    c. Pressure head - force per unit area, such as pounds per square foot

    d. Velocity head - energy in motion or kinetic energy

   - e. Friction head - the loss of energy due to friction within the liquid and against the walls of the channel or pipe
   - f. Pump head - the ft.-lb. of energy given to each pound of water
   - g. Pumping - used to move liquids to a higher level or increase the rate of flow

2. Weirs - a rectangular or V-notch opening with sharp edges

3. Venturi meter - a flow measuring device that is installed in a pipe line and consists of a throat of a given inside diameter with a tapered section on either side to converge with the pipe diameter. Flow is checked by the difference in pressure head between a tap point at the throat and another just before or after the convergence.

4. Parshall flume - this uses the same principle as the venturi meter, but it is used with open channels.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

A way in which flow measurement could be demonstrated by the student is with the construction of a small scale Parshall flume. This could be made small enough to use in the flow measurement of tap water. The channel could be constructed from aluminum with a wood frame and caulking to seal the joints.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

An essay response should be used to determine the student's understanding of the need to measure flow in a water treatment plant. He must demonstrate the principles of flow measurement and the ability to determine flow rates. He must also be able to describe what types of measuring devices there are and the advantages of each.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A sheet of aluminum is needed which could be made into a channel 10 feet long and 4 ' wide with 4" sides. The throat should be 1" wide with the outlet section diverging more rapidly to the original channel width than the inlet section.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 19-39.

   This reference provides the basic definitions which the student should know and the means of measuring rate of flow by the student. Examples of problems are also provided in this Chapter.

BACTERIOLOGY

UNIT CONCEPT: The quality of the water which has been treated in a water treatment plant should meet the requirements for domestic use in that it must be free of harmful organisms that might cause disease. Therefore, it is important that the operator is familiar with the water quality tests.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Demonstrate the proper use of a table of "most probable numbers" (MPN) for various combinations of positive results in a series of fermentation tube implants.
2. Name two water-borne diseases that are used as indicators of water pollution.
3. Perform a multiple tube fermentation test, a membrane filter test, and a standard plate count test according to the local or state treatment plant standards.

B. INSTRUCTIONAL AREAS

1. Sampling
    a. Collection of a small portion of water which is representative of the total and is used for testing the quality of water
    b. A minimum of four samples per month is needed for a population of less than 4,000 and one additional sample is needed for each additional 1,000 population.
2. Testing
    a. Purpose of testing is to determine the existence of pollution with organisms of intestinal origin which are called coliform organisms.

b. Presumptive test - used to determine if fermenting bacteria are present which is evidenced by the production of gas

(1) Five tubes of lactose broth
(2) Ten milliliters of the water sample is added to each tube with a sterile pipette.
(3) Incubate samples at 35° C. fo [illegible] four hour time period.
(4) Check for gas.
(5) If no gas was produced, the [illegible] are incubated for an additional twenty-four hours.

c. Confirmed test - not all lactose fermenters belong to the coliform group; therefore, a positive presumptive test requires a different type of test to determine the presence of coliform bacteria.

(1) A loop full of lactose broth is taken from the positive presumptive test to inoculate a green bile media.
(2) Incubated at a temperature of 35-37° C. for a period of twenty-four to forty-eight hours
(3) Interpretation of analysis:

    (a) If gas is produced in the green bile, the test is positive and the water is unsafe.
    (b) If gas is not produced, the test is negative and the water is safe.

(4) Presentation of results:

    (a) Gas in twenty-four hours - 2/5
    (b) Gas in forty-eight hours - 4/5
    (c) Brilliant green bile

(5) Interpretation:

    (a) Two of the 5 tubes of lactose broth had produced gas after twenty-four hours incubation.
    (b) Four of the 5 tubes of lactose broth had produced gas in forty-eight hours.
    (c) All samples failed to ferment or produce gas in the confirm test.
    (d) Results were negative; the water is safe.

d. Most probable number (MPN) - used to estimate the number of coliform bacteria present in a sample

e. Membrane filter test - this involves the use of very thin films of cellulose which allow water to pass through but retain bacteria.

f. Standard plant count - a useful test which determines the efficiency of chlorination or recontamination of a water supply after chlorination

g. Viruses - it is doubtful if present water treatment methods are adequate to actually destroy viral infectious agents.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. It is important for the student to receive the experience of testing for bacteria of the coliform group. This experience could be gained by following the procedures given on pages 292-300 in the "New York Manual." The tests include the multiple tube fermentation test, the membrane filter test, and the standard plate count test.

2. He should also gain experience by working sample problems using the table of most probable numbers. An example is as follows:

No. of Positive Tubes		
5 - 10 ml.	1 - 1 ml.	1 - 0.1 ml.
4	1	0

What was the MPN? 21

(See Tables I - V)

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate how to use the table of most probable numbers (MPN). He must also know the indicators of water-borne disease and how to perform the multiple tube fermentation test, membrane filter test, and the standard plate count test.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A list of equipment required to perform the tests is included on pages 292-300 of the "New York Manual."

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 75-97 and 292-300.

   Greater detail is provided in this text than in the "Texas Manual" concerning microbiology. Along with the multiple fermentation tube test, consideration is also given the newer method of using a membrane filter to locate coliform organisms. Chapter 21 provides a good description of the procedures to follow for the multiple tube fermentation test, the membrane filter test and the standard plate count test.

2. Water Works Operation. Unit II. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 1-6.

   This reference deals mainly with the collection of water samples and the use of the multiple fermentation tube test to determine the presence of coliform organisms.

REPORTS AND RECORDS

UNIT CONCEPT: Reports and records are valuable in showing the efficiency of each treatment unit or process, and they serve as a basis for supporting requests for additional plant equipment and facilities such as new pumping equipment or a change in chemicals to be used for coagulation.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. List the types of records required and demonstrate how they are properly completed.
2. Properly analyze log sheets in relation to the plant operation.

B. INSTRUCTIONAL AREAS

1. Raw water records - records for the untreated water entering the plant
    a. Amount of water used
    b. pH
    c. Temperature
    d. Alkalinity
    e. Hardness
    f. Chloride content
    g. Fluoride content
    h. Carbon dioxide
    i. Dissolved oxygen

2. Finished water records - records for the treated water leaving the plant
    a. Amount of water pumped into the distribution system
    b. pH
    c. Temperature
    d. Alkalinity
    e. Hardness
    f. Carbon dioxide
    g. Fluoride content, if added
    h. Chloride content
    i. Dissolved oxygen
    j. Bacteriological and chemical analyses
3. Pressure records - pressure recorders should be placed at strategic points in the distribution system to record pressure. They are used to determine line extensions and fire protection needs.
4. Chemical feed records - records are needed on the pounds, ppm, or gpg (grains per gallon) of each chemical applied each day for use in completing the next year's budget.
5. Chlorine records - provide a check on the amount of time the drums of chlorine gas will last
6. Filter records
    a. Loss-of-head reading on each filter each hour
    b. Total hours of operation for each filter
    c. Gallons of wash water used
    d. Length of time and rate of backwash
    e. Percent of finished water needed for filter washing

f. Condition of the filter and the sand

7. Meter and motor records

   a. Length of operating time

   b. Kilowatt hours used by each motor each day

   c. Records of maintenance performed

8. Monthly reports - needed as a comparison of production costs for different time periods

9. Annual report - composed of the twelve monthly reports and includes a discussion of the future plans and needs

10. Other reports needed, if applicable

    a. Well records

    b. Pumping equipment records

    c. Tank and structure records

    d. Maps and drawings

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. One possible way of providing the student with the necessary experience in completing records is to have him accompany an operator and collect a duplicate set of records for the day.

2. Some copies of log sheets could be obtained from a water treatment plant and analyzed as to changes made in the plant operation. An example would be the monthly amounts of water used by a plant as follows:

Millions of Gallons

Jan.	20.45	Apr.	20.98	July	24.50	Oct.	22.63
Feb.	18.54	May	23.24	Aug.	24.95	Nov.	21.58
Mar.	22.07	June	22.60	Sept.	24.82	Dec.	21.83

Plot the values on a graph and explain the curve.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. The student should properly complete a daily log sheet by taking the necessary readings during an eight hour shift and complete at least six of the following types of records:

   a. Raw water records

   b. Finished water records

   c. Records of water pressure

   d. Chemical feed records

   e. Chlorine records

   f. Filter records

   g. Meter and motor records

   h. Well or pumping equipment records

2. Visit a water treatment facility to complete log sheets along with an operator.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Copies of log sheets from a water treatment plant which the student can use for purposes of analysis

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 223-228.

   A discussion is provided on the importance of records, their functions, information needed, and how they should be kept. Also a short presentation is included on how reports are to be written.

2. Water Works Operation. Unit II. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 63-66.

This reference outlines the information needed in the records and reports for the plant operation.

3. Water Works Operation. Unit III. College Station, Texas: Engineering Extension Service, Texas A & M University. Pp. 81-82.

A short description is provided concerning the records needed for the facilities which rely on well water.

SAFETY

UNIT CONCEPT: Accidents do not just happen; they are caused, usually by indifference, neglect, bad supervision and/or poor design and arrangement of equipment and facilities.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Demonstrate the proper use of rescue equipment and first aid techniques.
2. Demonstrate rational reactions in role-playing emergency situations.
3. Identify safety hazards with the equipment and facilities.
4. Identify the location of rescue equipment.

B. INSTRUCTIONAL AREAS

1. Basic plant maintenance needed for accident prevention
    a. Keep a clean, neat and orderly plant.
    b. Establish a systematic plan for the daily operation.
    c. Establish a routine inspection and lubrication schedule.
    d. Keep date and records for each piece of equipment, noting unusual incidents and operation problems.
    e. Think safety.
2. Electrical equipment - most failures are due to:
    a. Dirt
    b. Moisture
    c. Friction

   d. Vibration

3. Lubrication
   a. Study the manufacturer's recommendations.
   b. Avoid over lubrication of motor bearings.
4. Pumps - daily inspection is needed of the following:
   a. Bearings for heat and noise
   b. Operating speed of motors
   c. Control equipment for cleanliness and condition
   d. Pump operation for vibration and noise
   e. Packing glands for excessive leakage
5. Tools
   a. It is important to have the proper tools for the type of job which must be done.
   b. A regular storage place is needed.
   c. Tool access should be assigned to one man.
6. Plant structures - periodical checks should be made of the water plant structures and buildings.
7. Plant grounds - grading, roads, and lawns are needed for good public relations.
8. Hazards encountered on the job:
   a. Falls
   b. Electric shock
   c. Infections
   d. Asphyxiation

e. Explosions

f. Toxic dusts

g. Dangerous chemicals

h. Fires

i. Toxic or flammable gases and vapors

j. Inadequate help

k. First aid

    (1) Controlling severe bleeding
    (2) Interruption of breathing
    (3) Shock

9. Location of emergency equipment

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Invite the fire department to demonstrate methods of artificial respiration and other rescue operations.

2. Conduct some role-playing exercises in which the student is placed in an emergency situation and must decide the best possible action from a given set of alternatives.

3. Make a tour of a water treatment plant and identify the locations of emergency equipment and why they are there.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. The student must demonstrate the proper use of artificial respirators, chlorine gas masks, fire extinguishers, the proper methods of lifting, and first aid techniques.

2. In a simulation exercise, the student should be able to react quickly and make the right decision. He must also demonstrate good maintenance habits on the job.

3. The student must be able to identify equipment and facilities which do not have the proper safeguards.

4. The student should be able to locate the rescue equipment which is available in the treatment plant.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Appropriate emergency equipment

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 12-1 - 12-43.

   Even though this reference was written for a wastewater treatment operation, much of what is said concerning safety does apply to a water treatment operation as well. Therefore, if this reference is available in the classroom, it is important that those students studying to be water treatment operators read it as well.

2. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 229-239.

   A brief but good presentation is provided concerning plant maintenance and accident prevention. It should be remembered that if the basic design of the water treatment facility is good, and it is constructed with the best material and workmanship, then there should be a minimum of maintenance required.

CHEMISTRY IN A WATER TREATMENT PLANT

UNIT CONCEPT: Many processes in the water treatment plant involve the use of chemicals. In order for the plant operator to understand and control these water purification processes he must have some knowledge of chemistry.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Identify the symbols and formulas of the chemicals used in the water treatment plant with the elements and compounds they represent with 100% accuracy.

2. Calculate the amounts of reactants required to produce the desired amounts of products with the use of equations.

3. Determine the amount of an acid required to neutralize a given base.

4. Select the matching indicator to agree with the acid base titrations.

5. Calculate the percentage of concentration of a given solution.

B. INSTRUCTIONAL AREAS

1. Chemical symbols and formulas of the materials used in a water treatment plant

2. Laws of chemistry

   a. The law of the conservation of matter

   b. The law of definite proportions

   c. The law of multiple proportions

   d. The law of combining weight

3. Chemical calculations - equations are used to calculate the amounts of reactants needed to produce desired quantities of products.

4. Ionization - water has the property of splitting some molecules into positively and negatively charged atoms; this process is called ionization.

5. Acids, bases and salts

    a. An acid yields H^+ ions when it dissociates in water.

    b. A base yields hydroxyl (OH^-) ions when it dissociates in water.

    c. Salts do not yield H^+ or OH^- such as when sodium chloride dissociates in water to form $Na^+ + Cl^-$.

6. pH value

    a. When the hydrogen ion concentration is highest, the pH is the lowest.

    b. When the hydrogen ion concentration is lowest, the pH is the highest.

    c. A pH of 7 is the point of neutrality.

7. Neutralization of acids and bases - when an acid solution and an alkaline solution each containing equivalent ions, hydrogen and hydroxyl, are mixed, the H^+ ions combine with the OH^- ions to form water. This reaction is called neutralization.

8. Indicators & Titration - an indicator changes color according to the reaction taking place. Titration is the addition of small increments of one solution to another to bring about color change. The indicators which are used for acid base titrations are very sensitive to slight changes in pH.

9. Solutions

    a. Concentrated solutions

    b. Dilute solutions

    c. Percentage of concentration

d. Molar concentration

e. Normal solution

f. Standard solution

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

The student should learn how to use indicators for making acid base titrations. Use laboratory practice exercises in neutralizing acids with various bases. Problems could be given for the purpose of practicing concentrations of various solutions. Also, a number of matching exercises could be developed using the chemical names and the chemical formulas. Practice should be provided in balancing chemical equations and working practical calculation problems.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must be able to identify the chemical symbols with the names of chemicals. He must also be able to use equations in order to calculate the amounts of reactants needed to produce the desired amounts of products. The use of indicators should be demonstrated by the student in making acid base titrations; and he should be able to calculate the percentage of concentration of given solutions.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Chemicals, using only the formula for identification
2. Supplies necessary for making acid base titrations with indicators

F. EXAMPLES OF SUPPORTING REFERENCES

1. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 45-73.

   This reference provides some basic information on chemistry which is needed to help plant operators understand and control the water treatment processes. It is especially important to know the chemical symbols, formulas and the process for making chemical calculations.

2. An additional reference for this chemistry unit would be a good high school chemistry book.

MATHEMATICS IN A WATER TREATMENT PLANT

UNIT CONCEPT: Many processes in the water treatment plant involve the use of mathematics. In order for the plant operator to understand and control these water purification processes, he must have some knowledge of mathematics.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to accurately calculate each of the following mathematical computations at least 85% of the time:

1. Convert weight and measurement units from the English system to the metric system.
2. Work mathematical operations using fractions, decimals and percentages.
3. Transform physical units of measurement from one size of unit to another size.
4. Round off values to be correct within one half unit in the last place recorded by the instrument or gauge.
5. Calculate solution strengths by using:
    a. The weight of active chemical per 100 pounds of solution
    b. The weight of active chemical per gallon of solution
6. Calculate the amount of water or weak solution needed to dilute a strong solution as given amount.
7. Calculate the area of a rectangle, trapezoid, and a circle.
8. Calculate the volume of a cylinder, square, and a cone.

B. INSTRUCTIONAL AREAS

1. The uses of mathematical computations in the water treatment plant

2. Units of weights and measurement

   a. Linear

      (1) Inch - centimeter
      (2) Foot - inch
      (3) Meter - centimeter - inch - foot
      (4) Centimeter - millimeter

   b. Area

      (1) Square inch - square foot - acre
      (2) Square mile - acre

   c. Volume

      (1) Cubic inch - cubic foot - gallon
      (2) Gallon - quarts - liters - milliliters

   d. Weight

      (1) Pound - ounces - grams - kilograms
      (2) Pound - grains

   e. Temperature

      (1) °F. = 9/5 °C. + 32
      (2) °C. = (°F. - 32) 5/9
      (3) Water freezes at 32° and boils at 212° fahrenheit.

3. Fractions, decimals and percentages

   a. Addition

   b. Subtraction

   c. Multiplication

   d. Division

4. Transformation of units - multiplication, division and cancellation of physical units

5. Rounding off values

   a. Every measuring device has a sensitivity limit below which a change in the item measured will not register.

   b. Rules in rounding numbers:

      (1) If the part to be dropped is less than 5, drop that part without changing the next number to the left.
      (2) If the part to be dropped is greater than 5, increase by one the next number to the left.
      (3) If the number to be dropped is exactly 5, the next number on the left is changed to the nearest even number (i.e., if it is even, no change is made; if it is odd, it is increased by one.)

6. Solution strengths - determine the following for a given solution of a given specific gravity:

   a. The weight of one liter in grams

   b. Grams of acid per liter

   c. Pounds of acid per cubic foot

   d. Pounds of acid per gallon

   e. Gallons of a given strength of acid required to treat a given flow per hour at a rate given in parts per million (ppm)

7. Solution mixing

   a. Diluting strong solutions with weak solutions to achieve a given solution concentration

   b. The use of ratios to determine the amount of dilution needed

8. Determination of area and volume - formulas and sample problems to determine:

   a. Area of a rectangle, trapezoid, and a circle

   b. Volume of a cylinder, square, and a cone

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

Since both the work of a water treatment operator and the operator's certification examination require a knowledge of basic mathematics, it is important that students are provided many opportunities to practice mathematical calculations. There are many mathematics books available, but if the mathematics problems can relate to water treatment, they will have much more meaning to the student. Simulation games could be devised which have the students solve treatment plant situations and problems, identifying the math skills which are appropriate in the solutions. The references listed in section E. provide direction in developing the types of mathematical skills which the student needs.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must know how to convert weight and measurement units from the English system to the metric system, perform mathematical operations using fractions, decimals and percents, change physical measurements into their most workable units and round off numbers. He must also be able to calculate strengths of solutions, areas of rectangles, trapezoids and circles, and the volume of cylinders, squares and cones.

E. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 15-1 - 15-101.

   The basic mathematics discussed in this sewage treatment manual apply equally well for students studying water treatment.

2. Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 241-256.

   A brief presentation is provided on some of the mathematics that the student will need to understand and perform on the job. Additional instruction may be needed in mathematics for those students who have difficulty performing these calculations.

III

WASTEWATER TREATMENT

The Need for Treatment of Wastewater

Wastewater Facilities

Racks, Screens, Comminuters, and Grit Removal

Sedimentation and Flotation of Wastewater Materials

Principles of Primary Clarification and Equipment Operation

Principles of Secondary Clarification and Equipment Operation

Operating Characteristics of Trickling Filters

Maintaining and Operating Trickling Filters

Classification of Trickling Filters

Activated Sludge I

Activated Sludge II

Activated Sludge III

Activated Sludge IV

Sludge Digestion and Handling I

WASTEWATER TREATMENT (Continued)

Sludge Digestion and Handling II

Sludge Digestion and Handling III

Waste Treatment Ponds I

Waste Treatment Ponds II

Disinfection and Chlorination I

Disinfection and Chlorination II

Maintenance of Treatment Plant

Plant Safety and Good Housekeeping

Sampling Receiving Waters

Laboratory Procedures and Chemistry

Basic Mathematics and Treatment Plant Problems

Analysis and Presentation of Data

Records and Report Writing for Wastewater Treatment Operation

THE NEED FOR TREATMENT OF WASTEWATER

UNIT CONCEPT: In order that wastewater can be reused in a safe manner, it must be purified and sanitized from pollutants and disease-producing organisms which are typically carried or produced in the wastewater.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Describe how water may pick up dissolved substances and what they may be.
2. List four types of pollution.
3. Identify the causes of oxygen depletion when organic wastes are discharged into water.
4. Identify the source of disease-causing organisms found in wastewater and the most frequently used means of disinfection.
5. List the types of solids which make up the total solids in wastewater.

B. INSTRUCTIONAL AREAS

1. Prevention of pollution
2. Definition of pure water
3. Types of waste discharges
4. Effects of waste discharges
    a. Sludge and scum
    b. Oxygen depletion

c. Other effects

(1) Clarity and color of receiving waters
(2) Acidity or alkalinity
(3) Heavy metals
(4) Taste and odor-producing substances
(5) Nutrients

d. Human health

5. Solids in wastewater

a. Types of solids

b. Total solids

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Make a check of industry in your area as to the types of wastes which they produce and how they treat them. See the "New York Manual,"[2] pages 117-126.

2. Collect water samples from various streams after a rain and use an Imhoff cone to measure the settleable solids. See the "New York Manual," pages 133-134.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

A paper and pencil test should be used to determine the student's ability to:

1. Describe how water picks up dissolved substances and the types of pollution which can thus be found in water.

2. Identify causes of oxygen depletion as well as sources of disease-causing organisms.

3. Describe the types of solids which compose the total solids in wastewater.

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[2] Referring to the manual cited in F.2., Manual of Instruction for Sewage Treatment Plant Operators, "New York Manual" will be used, in text, throughout the area of wastewater treatment.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Two or more Imhoff cones and a wooden rack to hold them

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 2-1 - 2-13.

   This reference provides a basic background of the purposes for waste treatment and the effects of wastes if they are discharged into streams without proper treatment.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 1-14, 117-126, 133-134.[3]

   A few additional points are included in this reference which are useful for the student to review.

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[3] This manual is available from the Health Education Service, P. O. Box 7283, Albany, New York, 12224.

WASTEWATER FACILITIES

UNIT CONCEPT: Various types of wastewater handling and treating facilities need to be considered depending upon the source of wastewaters, the degree and types of pollutants, and the destination and use of the wastewater following treatment.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Identify the importance of a familiarity with the wastewater collection and transportation network for a wastewater treatment operator.
2. List three types of sewer systems and the advantages and disadvantages of each.
3. Describe the steps in the pretreatment process of wastewater and the purpose of each.
4. Describe the primary wastewater treatment process and its purpose.
5. Describe the secondary wastewater treatment process and its purpose.
6. Explain the purpose of disinfection and how it is best accomplished.

B. INSTRUCTIONAL AREAS

1. Collection of wastewater
    a. Sanitary sewer
    b. Storm sewer
    c. Combined sewer
2. Treatment plants - removal of wastes from water to reduce its threat to the public health before it is discharged from the plant

3. Pretreatment

    a. Screening - a bar screen to collect trash carried by the wastewater which could harm the equipment

    b. Shredding - use of a device for cutting or shredding material remaining in the wastewater after passing through the bar screen

        (1) Barminutor
        (2) Comminutor

    c. Grit chamber - a long, narrow trough designed to slow the velocity of the wastewater to one foot per second which allows the heavy mineral material to settle

4. Flow measuring devices - which measure the quantity of wastewater flow

    a. Parshall flume

    b. Weir

    c. Venturi meter

5. Primary treatment

    a. A large basin reduces the flow velocity to 0.03 foot per second which allows settleable solids to fall to the bottom of the tank.

    b. Collector flights or plows are used to remove the sludge from the tank.

    c. The scum on the wastewater surface is removed by the collector flights as they travel on the surface or by a rotating blade on the surface.

    d. Sludge and scum are pumped to the sludge handling facilities.

    e. Clear surface water passes over a weir at a low velocity.

6. Secondary treatment

    a. Trickling filter

(1) Composed of a bed of 1 1/2" to 5" rock
(2) Overhead rotating distributor which applies wastewater to the rocks
(3) Aerobic bacteria in the filter bed feed on the passing wastewater and form activated sludge.

b. Aeration tanks

(1) Aeration tanks can be used in place of trickling filters.
(2) Aerobic bacteria multiply rapidly as they are supplied with sufficient food and oxygen.
(3) The tank effluent is called "mixed liquor" containing a large population of organisms.
(4) The mixed liquor is piped to a secondary clarifier where the organisms settle to form activated sludge.

c. Secondary clarifiers

(1) Purpose is to remove the activated sludge from the effluents of the trickling filters and aeration tanks.
(2) The activated sludge is removed to the primary clarifier.
(3) The clear effluent flows over a weir at the top of the tank.

7. Solids handling and disposal

a. Digestion

(1) Settled sludge from the primary clarifier is pumped to a digestion tank.
(2) The digestion tank is sealed to exclude air and create a favorable environment for anaerobic bacteria.
(3) Two types of bacteria are present - "acid formers" and "gas formers."
(4) When the solids are allowed to settle, a liquid known as supernatant is left which is displaced each time raw sludge is added; the displaced supernatant is then returned to be mixed with the incoming raw wastes of the plant.
(5) Scum blankets develop on the surface of the supernatant unless mixing of the digester contents occurs.
(6) Above the water level is the gas collection area for the digester gas composed of 70% methane and 30% carbon dioxide.

   b. Dewatering and disposal - digested sludge is periodically removed from the digester tank.

      (1) Water is removed by sand drying beds, lagoons, centrifuges, and vacuum filters.
      (2) Sludge can then be burned, buried, or used as fertilizer.

8. Waste treatment ponds

   a. Settleable solids fall to the bottom.

   b. As they decompose and use the dissolved oxygen, anaerobic bacteria continue the decomposition.

   c. Aerobic bacteria, algae, and other microorganisms feed on the dissolved solids in the upper layer of the pond.

9. Tertiary treatment - to reduce the nutrient content.

   a. Coagulation - sedimentation - as it is used in the water treatment plants

   b. Absorption

   c. Electrodialysis

10. Disinfection - killing of pathogenic organisms by creating a harsh environment

   a. Strong light

   b. Heat

   c. Oxydizing chemicals - chlorine

   d. Acids

   e. Alkalies

   f. Poisons

      (1) Chlorine gas is the most commonly used disinfectant.
      (2) A strong chlorine solution is mixed with the effluent from the secondary clarifier.
      (3) A chlorine contact basin which allows 20 to 30 minutes of contact time for adequate mixing

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Make a drawing which includes the various stages of treatment for a wastewater plant and identify each stage.
2. Visit a lagoon-type treatment operation, a primary, a secondary, and a tertiary stage plant operation and observe and discuss the characteristics of the effluent from each of the four.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

Using a paper and pencil test, the student should demonstrate his awareness of important considerations of a wastewater collection and transportation network and the advantages of the different types of sewer systems. He must also demonstrate an understanding of the pretreatment, primary treatment, and secondary treatment processes as well as the process of disinfection of the wastewater treatment plant. An example test item might be to list the major equipment and facilities required for each - primary, secondary, and tertiary treatment - and describe at least three functions each stage serves in clarifying the water.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Sufficient drawing equipment to do an adequate representation of the facilities in a wastewater treatment plant.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 3-1 - 3-25.

   This reference provides considerable detail in presenting an overall picture of the operations performed in a wastewater treatment plant for the collection, treatment, and disposal of wastewater.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 23-26.

   A brief description is provided in this manual which serves as a review of the material covered in the "Sacramento Manual."

RACKS, SCREENS, COMMINUTERS, AND GRIT REMOVAL

UNIT CONCEPT: Several materials such as rocks, cans, and rags will often be carried by wastewater to the treatment facilities where equipment is required to remove the debris from the plant influent before it can harm the other equipment.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Identify the precautions to observe when working in a wastewater treatment plant.
2. List the equipment used to remove the large materials such as rocks, cans, and rags from the influent.
3. List the advantages of comminuting machines as compared to screens.
4. Calculate the velocity of flow in the grit chamber.
5. Identify ways that the flow velocity can be maintained in a grit chamber at one foot/second.
6. Calculate the cubic foot of grit per million gallons (MG) of flow when given the average plant flow in million gallons per day (MGD) and the average cubic feet of grit removed daily.
7. Identify the purposes of washing grit in operating the sedimentation and flotation unit.
8. List the purposes of pre-aeration of the wastewater.

B. INSTRUCTIONAL AREAS

1. Safety

a. Wastewater treatment plants have one of the highest accident rates reported by industry.

b. Prevent accidents by thinking safety.

c. Good personal hygiene must always be practiced by operators.

2. Purpose of pretreatment

a. Removal of large materials which could otherwise harm the plant equipment

b. Preventing plant break-downs

3. Screens and racks

a. Racks - parallel bars with a 3" or 4" spacing or more between the bars

b. Bar screens - parallel bars with a 1" or 2" spacing between the bars

c. Manually cleaned bar screens

(1) Require frequent cleaning
(2) Channel can be blocked
(3) Organic materials can settle out
(4) Odor and corrosion can result
(5) Plants can receive shock loads if the screens are cleaned infrequently

d. Mechanically cleaned screens

(1) Traveling rakes to remove debris from the channel
(2) Scrapers, rotating brushes, water sprays, or air jets are sometimes used

4. Disposal of screenings

a. Burial

(1) 6" of earth cover immediately
(2) Final earth cover to prevent flies from reaching the screenings

(3) Determine the number of days a disposal site can last by dividing the disposal site volume by the daily volume:

$$\frac{\text{Pit capacity, cubic feet}}{\text{Filling rate, cubic feet/day}} = \text{days of use}$$

b. Incineration

c. Shredding or grinding - if returned to the influent it can impose a great load on the plant.

5. Comminution

   a. Purpose is to shred solids and leave them in the wastewater

   b. Consists of a rotating drum with slots to allow wastewater to pass through

   c. A rubber seal prevents leakage under the drum and should be checked when checking the rock and scrap metal trap.

   d. A mercury seal is used to keep water out of the bearings and should be checked annually or after a particularly heavy flow.

   e. Caution must be observed when using mercury since it is poisonous and the fume can be fatal.

6. Grit removal

   a. Composed of sand, eggshells, cinders, and other mineral matter

   b. Grit mixed with cementing materials can form a solid mass.

   c. Important to remove grit as soon as possible

7. Grit chambers

   a. Settling tank with a wastewater flow of one foot per second is best.

      (1) Slow enough to allow the grit to settle
      (2) Fast enough to hold the organic material in suspension

b. Velocity can be maintained by multiple-channels or proportional weirs.

c. Estimating velocity

(1) Velocity, ft./sec. = $\frac{\text{Distance traveled, ft.}}{\text{Time, sec.}}$

(2) Average velocity, ft./sec. = $\frac{\text{Flow rate, cu. ft./sec.}}{\text{Area, sq. ft.}}$

d. Length of channel needed

(1) Settling time, sec. = $\frac{\text{Depth, ft.}}{\text{Settling rate, ft./sec.}}$

(2) Length, ft. =

$$\frac{(\text{Depth of chamber, ft.})(\text{Flow velocity, ft./sec.})}{\text{Settling rate, ft./sec.}}$$

e. Hand removal of grit

(1) Frequency is determined by experience.
(2) Burial is most satisfactory disposal method.
(3) Precautions must be taken against slipping and back strain.
(4) Covered grit chambers may contain dangerous gases.

f. Mechanical grit collector mechanisms

(1) Chain-driven scrapers (flights)
(2) Conveyor belts with buckets attached
(3) Aerated grit chamber moves the grit along the bottom to the grit hopper for removal by a conveyor system.

8. Quantities of grit

a. One to 4 cubic feet of grit per million gallons if it is a separate wastewater collection system

b. Four to 15 cubic feet of grit per million gallons from a combined collection system

c. Always an increase in grit is seen during a storm period.

9. Grit washing

    a. Some organic matter may settle out with the grit, making it necessary to wash the grit before using it as a fill material.

    b. Most use water to wash the grit.

    c. Aerated grit chambers produce grit which is free of organic matter and does not need washing.

10. Pre-aeration

    a. Freshen the wastewater, remove gases, add oxygen, promote flotation of grease, and aid coagulation

    b. Consists of aerating wastewater 10 to 30 minutes

    c. A rate of 0.5 to 1.0 cubic feet of air is added per gallon of wastewater treated.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Calculate the velocity of flow for a stream using the recommended procedures found in the "Sacramento Manual" on page 4-20.

2. Calculate the amount of grit in a million gallon flow when you know the average plant flow in a nearby plant and the average cubic feet of grit which are removed daily.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his awareness of important precautions to observe when working in a wastewater treatment plant: his knowledge of the pretreatment equipment, their advantages, and the purpose of washing grit and of pre-aeration. He must also be able to calculate the velocity of flow and the cubic feet of grit in a million gallon flow. An example evaluation would be to have each student list a minimum of fifteen items which are potential hazards in and around the treatment equipment and list one or more ways to reduce the hazard or means of preventing the hazard for each item.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Stop watch
2. Flow rates of a nearby plant
3. Average daily cubic feet of grit removed

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 4-1 - 4-38.

   This reference provides a very good, detailed and well-illustrated discussion of the pretreatment process, its importance, and the hazards involved.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 27-29.

   A brief description is provided in this manual which serves as a review of the material covered in the "Sacramento Manual."

SEDIMENTATION AND FLOTATION OF WASTEWATER MATERIALS

UNIT CONCEPT: Following removal of large solids in the grit chamber, the flow velocity is slowed to allow the organic materials to settle to the bottom or float to the surface.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. List the items to consider before starting up a new sedimentation unit or one which has been out of service for a period of time.
2. Identify the daily activities that an operator must attend to during normal operations of a wastewater treatment plant.
3. Perform the control tests which are used in the primary treatment plants to measure the efficiency of the clarifiers.
4. Identify the possible sources of poor clarifier performance and the corrective action which should be taken.
5. Identify the ways to determine if sludge, being removed from a tank, is thin or concentrated without a laboratory analysis.
6. Given either a circular or rectangular type clarifier, list a minimum of five ways to keep clarifiers operating properly.
7. List safety precautions to observe.

B. INSTRUCTIONAL AREAS

1. Start-up of clarifier
    a. Circular clarifiers - check items:
        (1) Control gates for operation
        (2) Clarifier tank for sand and debris

    (3) Collector drive mechanism for lubrication, drive alignment, and complete assembly
    (4) Squeegee blades on the collector plows for proper distance from the floor of the tank
    (5) Tank sumps or hoppers and return lines for debris and obstructions
    (6) Record the time required for the plows to make one complete revolution around the tank.
    (7) Record the amperage that the motor is drawing.

  b. Rectangular clarifiers - check items:

    (1) Control gates and weirs for operation
    (2) Tank hoppers and channels for debris and obstructions
    (3) Check to be sure the flights are straight across the tank.
    (4) Lift each flight off the rail and apply a light grease or 90 wt. oil to the shoe and rail.
    (5) Check each flight to be sure there is 1" to 2" of clearance between the wall and the end of the flight.

2. Daily operation and maintenance

  a. Inspection - frequent inspections with a stop, look, listen and then think routine

  b. Clean-up - use water under pressure to wash off accumulations of solid particles, grease, slime, etc., from the exposed parts of the structure and equipment.

  c. Lubrication - grease all moving equipment and check oil levels in motors.

  d. Preventive maintenance - read the manufacturer's instructions.

  e. Flight boards - check for loose bolts and corrosion.

  f. Chain and sprocket - check for wear and extra slack.

  g. Record keeping - keep a pocket notebook to record any unusual observations which should be transferred to the plant record sheet.

  h. Sampling and laboratory analysis - determine the efficiency of the clarifiers.

i. Sludge and scum pumping - remove sludge at regular intervals to prevent a septic condition from developing.

3. Sampling and laboratory analysis

   a. Tests which are made daily include:

      (1) Dissolved oxygen (DO)
      (2) Settleable solids
      (3) pH
      (4) Temperature
      (5) Chlorine residual

   b. Tests which are made weekly include:

      (1) Biochemical oxygen demand (BOD)
      (2) Suspended solids
      (3) Coliform group

   c. Samples are collected of the influent to the clarifier and the effluent from the clarifier to determine its efficiency for removing solids, bacteria, and BOD.

   d. Clarifier efficiency % = $\frac{(\text{In} - \text{Out})}{\text{In}}$ 100%

   e. Expected efficiencies:

Settleable solids	90 - 95%
Suspended solids	40 - 60%
Total solids	10 - 15 %
BOD	25 - 35%
Bacteria	25 - 75%

   f. Problems in clarifier performance:

	Problem	Check Items
(1)	Floating chunks of sludge	1, 2, 3, 4, 5
(2)	Large amounts of floating scum	2.3*, 2.4*, 2.5*
(3)	Loss of solids over effluent weirs	1, 2, 3, 4, 5, 2.7*, 2.8*
(4)	Low removal efficiencies	5
(5)	Low pH plus odors	1, 2, 3, 4, 5, 6
(6)	Deep sludge blanket, but pumping thin sludge	3, 2.1*, 2.2*, 2.3*, 2.6*

(7)	Sludge collector mechanism jerks or jumps	6
(8)	Sludge collector mechanism will not operate. Drive motor thermal overloads, or overload protective switches keep tripping.	6

*Check Item 2 is divided into two parts: (a) circular clarifier and (b) rectangular clarifier. If there is a floating scum problem (problem 2 above) check under (2) Collector mechanism, following, section (a) circular or (b) rectangular, items 3, 4, and 5, depending on the type of clarifier in the plant.

CHECK ITEMS

(1) Sludge pump

(a) Piston pumps

1. Ball check seating
2. Shear pin
3. Packing adjustment
4. Drive belts
5. High pressure switch
6. Pumping time

(b) Positive displacement pumps (screw pumps)

1. Pump gas bound
2. Rotor plugged
3. Drive belt
4. Packing adjustment
5. Pumping time

(c) Centrifugal pumps

1. Pump gas bound
2. Packing adjustment
3. Impeller plugged
4. Pumping time

(d) Air injector

1. Air supply
2. Foot valves
3. Slide valves
4. Electrodes
5. Pumping time

(2) Collector mechanism

(a) Circular clarifier

1. Drive motor
2. Overload switch
3. Skimmer dump arm

(a) Operation
(b) Rubber squeegee

4. Scum trough
5. Scum box

(b) Rectangular clarifier

1. Drive motor
2. Clutch and drive gear
3. Flights
4. Scum trough
5. Skimmer operation
6. Cross collector
7. Inlet line or slot
8. Target baffle

(3) Pipes and sludge sump - sometimes pipes or sumps may be cleaned by back flushing.
(4) Quality of supernatant return from digester
(5) Influent

(a) Change in composition or temperature
(b) Change in flow rate

An increase in flow rate can cause hydraulic overload. This can be determined by calculating the detention time, weir overflow rate, and surface loading rate. If a tank is hydraulically underloaded, a tank should be removed from service or effluent recirculated back to the primary clarifier to reduce the length of detention time.

(6) Jerking, jumping, or stalled collector mechanism

(a) Sludge blanket too deep - pump out sludge if mechanism is all right.
(b) Drive unit may have bad sprocket or defective chain link.
(c) Broken flight or rock or stick jammed between flight or squeegee blade and floor of tank.

If items (b) or (c) occur, or mechanism won't operate properly, tank must be dewatered. Never attempt to back up or help pull a collector mechanism because severe equipment damage will result.

4. It is important to withdraw sludge from the clarifier with as thick a concentration of sludge as possible.

a. The sound of the sludge pump is different for thick sludge than thin sludge.

b. Pressure gauge reading will be higher on the discharge side of the pump when the sludge is thick.

c. Sludge density gauge readings

d. Visual observation of a sample

e. Watching the sludge through a site glass in the sludge line

5. Maintenance of the clarifier

a. A record file where all repairs and regular maintenance can be recorded and where operating instruction manuals and names of the manufacturers' representatives can be found.

b. Always lubricate equipment at the recommended intervals.

c. Clean all equipment and structures regularly

d. Inspect and correct any irregularities.

e. When a sedimentation tank must be drained the wooden flights must be kept moist.

6. Safety

a. Gases in enclosed areas can be deadly.

(1) Hydrogen sulfide (H_2S) - a rotten egg odor
(2) Chlorine (Cl_2) - very irritating
(3) Carbon dioxide (CO_2) - odorless and tasteless
(4) Carbon monoxide (CO) - colorless and odorless
(5) Gasoline - cause of fires
(6) Methane (CH_4) - explosive and odorless

b. Falls can be avoided by:

(1) Cleaning up oil and grease spills promptly
(2) Walking, not running, in the plant
(3) Avoiding clutter in areas
(4) Proper use of handrails
(5) Providing safety features around openings below floor level

c. Drowning can be prevented by:

(1) Handrails and proper walkways
(2) Covers on open pits
(3) Life preservers and life lines readily available

d. Strains and overexertion can be prevented by using the proper wrenches and equipment to:

(1) Move stuck or reluctant valves
(2) Lift heavy objects

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. The student should become acquainted with the laboratory analysis for the basic control tests used in primary treatment plants. A detailed explanation of the procedures to follow is provided in Chapter 14 of the "Sacramento Manual." Samples should be collected in a wastewater plant under the supervision of an operator and taken to the school for testing. The tests which the student

should run include: dissolved oxygen, settleable solids, pH, temperature, BOD, suspended solids, chlorine residual, and coliform group bacteria.

2. The student should mathematically determine the efficiency of a primary clarifier as in the example on page 5-12 of the "Sacramento Manual." The figures used could be obtained from the weekly reports of a nearby wastewater plant.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

Each student should demonstrate his ability to properly check a sedimentation tank before starting it, perform the daily activities of an operator in the primary treatment section of a wastewater plant, and test the efficiency of the clarifiers. He should also remove concentrated sludge from a clarifier, identify possible sources of poor clarifier performance and ways to keep them operating properly. Also, the student should identify the safety features in a plant and ways to improve them.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A list of the general laboratory supplies needed for all experiments is provided on pages 14-215 - 14-218 of the "Sacramento Manual." The equipment needed for each specific test is listed under the headings of "apparatus" and "reagents" for that test in Chapter 14 also.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 5-1 - 5-24, 14-1 - 14-239.

   This reference provides information relating to the daily operations, maintenance, efficiency, control and safety in the operation of a clarifier in a wastewater plant. Check lists are provided which are important for locating problems with a clarifier.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 37-43.

   Much the same information is provided as in the "Sacramento Manual," but it is useful for review purposes.

PRINCIPLES OF PRIMARY CLARIFICATION AND EQUIPMENT OPERATION

UNIT CONCEPT: Primary clarification helps clear up wastewater by removing settleable and floatable materials before the effluent goes into a biological treatment.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain how temperature influences clarifier performance.
2. Draw a clarifier and indicate a possible way that short circuiting could occur.
3. Using the diameter, depth and flow rate of a clarifier in your wastewater plant, calculate the:
   - a. Detention time, in hours
   - b. Weir overflow rate, in gallons per day (gpd.)/ft.
   - c. Surface loading rate, in gpd./sq. ft.
   - d. Explain the effect of the surface loading rate on the efficiency of the clarifier.
4. Operate a clarifier properly.

B. INSTRUCTIONAL AREAS

1. The primary clarifier has the function of removing as much settleable and floatable material as possible.
2. Clarifiers are designed to provide a water velocity at which the suspended particles will settle.
3. Rate of settling is dependent on the weight of the particle, its size and shape, and the temperature of the liquid.

4. Problems:

   a. As temperature of the water decreases so does the settling rate decrease.

   b. When the velocity is greater in some sections of the tank than in others, short circuiting is occurring and the detention time may be too short.

   c. Prevent short circuits by weir plates, baffles, port openings, and proper design of the inlet channel.

5. Calculate the detention time when given the flow in gpd. and the tank dimensions.

   Detention time, hours =

$$\frac{\text{Tank Volume, cu. ft.} \times 7.5 \text{ gal./cu. ft.} \times 24 \text{ hr./day}}{\text{Flow, gpd.}}$$

6. Weir overflow rate can be determined when given the flow in gpd. and the lineal feet of weir.

$$\text{Weir overflow gpd./ft.} = \frac{\text{Flow rate, gpd.}}{\text{Length of weir, ft.}}$$

7. Surface settling rate can be determined when given the flow in gpd. and the square feet of liquid surface area.

$$\text{Surface loading} = \frac{\text{Flow rate, gpd.}}{\text{Area, sq. ft.}}$$

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

The student should calculate the detention time, weir overflow rate and surface loading rate of a clarifier in a nearby plant.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. The student must demonstrate his ability to explain the effects of temperature and short circuiting on a clarifier. He must also calculate the detention time, weir overflow rate and surface loading rate of a clarifier.

2. Problems of high temperatures should be presented and students define causes and procedures for regulating temperatures.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A clarifier in operation from which the student can receive the needed information to make his calculations

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 5-25 - 5-36.

   Information is presented in this reference concerning the primary clarifiers, their operation, design, and the calculation of the detention time, weir overflow rate, and surface loading rate of the clarifier.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 41-42.

   Additional sample problems are included in this reference which relate to weir loading, surface settling rate, and detention period.

PRINCIPLES OF SECONDARY CLARIFICATION AND EQUIPMENT OPERATION

UNIT CONCEPT: Secondary clarification removes solids formed as a result of the biological treatment unit.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Identify the purpose of secondary clarifiers in secondary treatment plants as well as the means of the sludge disposal from the secondary clarifiers.

2. Explain the use of the flotation process and the reason for it following primary sedimentation.

3. Describe a colloid, an emulsion, and the process of vacuum flotation.

4. Identify the two components of an Imhoff tank and properly operate it.

5. Identify the proper visual appearance of the sludge, maintain a level sludge blanket in the digester portion of the Imhoff tank and force the settled material into the digestion compartment.

6. Identify the critical factor related to the disposal of the septic tank effluent.

B. INSTRUCTIONAL AREAS

1. Secondary clarifiers

   a. Secondary clarifiers usually follow the activated sludge and trickling filter.

   b. A humus tank - a final settling tank for the sloughings from the trickling filter

   c. Sludge from the secondary tank is transferred to the primary settling tank or to the digestion system.

2. Flotation processes

   a. Colloid - a particle held in suspension due to its small size and its electrical charge

   b. Emulsion - one liquid held in suspension in another liquid

   c. Pump air into the mixture to cause the suspended material to float to the surface.

   d. Vacuum flotation - aerate the wastewater for a short time and then vacuum chamber pulls out dissolved air which floats the solids to the top.

3. Imhoff tanks

   a. Rarely constructed today

   b. Combines sedimentation and sludge digestion in two compartments

   c. The process is working well if the sludge is relatively odorless or has a musty smell and is dark in color.

   d. Solids may be forced into the digestion area with a squeegee or a chain.

   e. The direction of flow should be reversed periodically to provide an even sludge depth in the digestion compartment.

4. Septic tanks

   a. Used with homes and small populations

   b. No separate digestion compartment but it is similar to the Imhoff tank.

   c. Settleable solids must be pumped out and disposed of periodically.

   d. Septic tank effluent is disposed of in leach lines.

e. The ability of the soil mantle to leach the septic tank effluent is the critical factor in this disposal system.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

Continue with the laboratory analysis for the basic control tests of the primary treatment processes in the unit entitled, "Sedimentation and Flotation of Wastewater Materials."

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must be able to identify the purpose of secondary clarifiers and properly operate one. He must also explain the use of the flotation process, describe a colloid, an emulsion, and identify the critical factor related to septic tank effluent disposal. The student must demonstrate the proper operation of an Imhoff tank and identify the proper visual appearance of the sludge.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

As in the unit, "Sedimentation and Flotation of Wastewater Materials," a list of the general laboratory supplies needed for all experiments is provided on pages 14-215 - 14-218 of the "Sacramento Manual." The equipment needed for each specific test is listed under the headings of "apparatus" and "reagents" for that test in Chapter 14 also.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 5-37 - 5-42, 14-1 - 14-239.

   This reference discusses the use of secondary clarifiers, flotation, Imhoff tanks and septic tanks.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 31-37.

   Much greater detail is provided by this reference in the discussion of the Imhoff tank.

OPERATING CHARACTERISTICS OF TRICKLING FILTERS

UNIT CONCEPT: Trickling filters are a form of secondary treatment which convert dissolved or suspended materials into a form more readily separated from the water being treated. Proper operation of the trickling filters allows a biological slime growth to develop on a media with a large surface area and feed on the wastewater distributed over it, thus removing much of the pollution content.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain the purpose and process of the trickling filter.
2. List the items to be checked before placing a trickling filter into service and also the items which require daily inspection during normal operation; assist an operator in checking these items.
3. Explain the effect on the effluent of the clarifier which is not operated within the designed hydraulic loading ratio.
4. Calculate the efficiency of a trickling filter by comparing the suspended solids of the trickling filter influent with that of the trickling filter effluent.

B. INSTRUCTIONAL AREAS

1. Parts of a trickling filter
    a. Media - a large surface area upon which a biological slime growth develops.
    b. Underdrain system - a sloping bottom to collect the filter effluent.
    c. Distribution system - a rotary type distributor which consists of two or more horizontal pipes supported a few inches above the filter media.

2. Principles of operation

    a. Wastewater feeds bacteria, protozoa and other organisms living on the media.

    b. Suspended colloidal and dissolved organic matter are utilized by the organisms.

    c. Decomposed organic matter and excess or dead film are washed into the filter effluent.

    d. Ventilation is needed for the oxidation process; therefore, the filter voids must be kept open.

    e. Recirculation of filter effluent increases the filter efficiency.

        (1) Contact time is increased.
        (2) Higher velocities can be maintained to prevent ponding and provide ventilation.
        (3) Less problem with snail and filter fly breeding
        (4) Reduces the organic strength of the wastewater which prevents excessive biological growth
        (5) Evens out highs and lows in wastewater flows

3. Pre-start up of the filter

    a. Be present when new equipment is serviced.

    b. Rotate the unit by hand and observe for smooth turning.

    c. Check orifice settings if they are adjustable.

    d. Check spray nozzles to see that they are free of foreign objects.

    e. Check underdrain for foreign material and painted surfaces for damage.

    f. Check all valves for smooth operation.

4. Placing filter in service

    a. Start the flow of wastewater to the filter.

   b. Check for smooth operation, speed of rotation, and even distribution.

   c. Several weeks are required for full development of the biological slime.

   d. Heavy chlorination is used to reduce the pollutional load during the first few weeks of service.

5. Daily operation check list:

   a. Any indication of ponding

   b. Filter flies

   c. Odors

   d. Plugged orifices

   e. Roughness or vibration of the distributor arms

   f. Leakage past the mercury seal

6. Indicators of poor trickling filter performance

   a. Suspended solids

      (1) Heavy sloughing from the filters
      (2) High hydraulic loading
      (3) Shock loading

   b. BOD

      (1) Generally it will go up or down along with the suspended solids.
      (2) Varies with rate of recirculation
      (3) Aeration in mains to keep the wastewater in aerobic condition

   c. Settleable solids - large amount indicates solids are being carried over the clarifier weir.

   d. Dissolved oxygen - if the suspended solids and BOD are within range, the DO should be also.

e. Chlorine demand - excessive solids in the effluent will make it difficult to maintain a chlorine residual.

f. Clarity - this is primarily related to the amount, size, shape and characteristics of the suspended solids in the effluent.

g. pH - the pH will be in the neutral range as long as the suspended solids and BOD are within reasonable limits.

h. Coliform count - good disinfection is achieved if previous treatment processes do their job.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Develop a daily check list to be used with a trickling filter and use it to check the trickling filter in the plant. If possible, this should also be done with a start-up check list.

2. Collect samples of the trickling filter influent and effluent and determine the amount of suspended solids in each. Calculate the efficiency of the unit. See page 14-155, "Sacramento Manual."

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate how to properly inspect a trickling filter at the time of installation and on a daily inspection basis. He must also explain the purpose and process of the trickling filter and determine its efficiency. If the clarifier is not operated within the designed hydraulic loading, due to recirculation from the trickling filter, the student must explain its effect on the clarifier effluent.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Trickling filter in a wastewater plant

2. Samples of trickling filter influent and effluent; use the equipment listed on page 14-156 of the "Sacramento Manual."

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 6-1 - 6-23, 14-155 - 14-156.

A description is provided of the parts of a trickling filter, its operation, the items to consider in the trickling filter start-up and daily operation, and the problems you may have with a trickling filter.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 47-50.

   This includes much of the same information as in the "Sacramento Manual," but in a brief form.

MAINTAINING AND OPERATING TRICKLING FILTERS

UNIT CONCEPT: In order for the treatment system to work effectively, regular maintenance and safety practices need to be followed in using trickling filters. Also, necessary equipment adjustments should be made when changes occur in the quality of the effluent entering the filter.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Determine if ponding is a problem with a trickling filter. Correct it if it is a problem.
2. Control odor problems and filter flies in a trickling filter.
3. Identify the needed changes in operation of a trickling filter during icing conditions and make these changes as needed.
4. Explain the purpose of the mercury seal in a rotary distributor.
5. Drain a pint of oil from the distributor and check to see that it is clean and free of moisture; then return it to the unit and maintain the proper oil level.
6. Make an actual adjustment to change the rotational speed of the distributor.
7. Use the proper safety precautions when working on a trickling filter.

B. INSTRUCTIONAL AREAS

1. Daily operation problems
    a. Ponding
        (1) Causes

        - (a) Excessive organic loading without a higher ratio of recirculation
        - (b) Poor quality or improper media

    - (2) Prevention

        - (a) Eliminate ponding with high pressure hosing.
        - (b) Stir the filter surface.
        - (c) Dose filter with 5 mg./l of chlorine for several hours.
        - (d) Flood filter for twenty-four hours.
        - (e) Shut off filter flow for several hours.

- b. Odor prevention

    - (1) Maintain aerobic conditions in the sewer collection system and the primary treatment units.
    - (2) Check ventilation in the filter.
    - (3) Increase the recirculation rate to provide more oxygen to the filter bed and increase sloughing.
    - (4) Prevent wastewater from splashing from the distributor onto any exposed structures.
    - (5) If odors are a serious problem, use a masking agent.

- c. Filter fly prevention

    - (1) Increase recirculation.
    - (2) Correctly apply an approved insecticide to the filter walls and to the other plant structures.
    - (3) Flood filter for twenty-four hours at intervals frequent enough to prevent completion of the life cycle.
    - (4) Apply a low dosage of chlorine weekly.
    - (5) Cut shrubbery, weeds and tall grass from the area.

- d. Ice problems

    - (1) Decrease the amount of recirculation.
    - (2) Operate two-stage filters in parallel rather than in series.
    - (3) Adjust orifices and splash plates to reduce the spray effect.
    - (4) Construct screens or covers to reduce heat losses.
    - (5) Break up and remove ice build-ups.
    - (6) Open end gates to provide a stream rather than a spray along the retaining wall.

(7) Add hot water or steam to the influent.

2. Maintenance

   a. Bearings and seals

      (1) Check oil weekly.
      (2) Drain a pint.
      (3) Check for droplets of water; if found, check the mercury seal.
      (4) If oil is dirty, clean with a mixture of 1/4 oil and 3/4 solvent.

   b. Distributor arms

      (1) Flush weekly by opening end dump gates one at a time.
      (2) Clean debris from orifices.
      (3) Coarse hardware cloth can be placed ahead of the filters to prevent plugging.
      (4) Observe the distributor daily for smooth operation.
      (5) Rotation speed should be one RPM.
      (6) Reduce rotation speed by installing orifices on the front of the arms.

   c. Fixed nozzles

      (1) Check and clean frequently.
      (2) Use screens ahead of filter if plugging is frequent.

3. Safety

   a. First shut off flow to filter.

   b. Allow filter to stop before attempting to work on it.

   c. Use extreme care when walking on the slime growth of the filter media.

   d. Do not carry oil in glass containers.

   e. Use rubber boots with deeply ridged soles.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

The student should check a trickling filter for a period of time to determine if it is operating properly; he must observe proper safety precautions, and perform the weekly maintenance duties.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to identify improper operations of the trickling filter and correct them. Observe safety precautions and properly perform weekly maintenance duties. Various problems of the trickling filters should be presented and the student should list methods for correcting them. Plant equipment and facilities should be used when feasible for the student to demonstrate his ability to solve the problem. In lieu of working out solutions on plant equipment, each student should provide written responses to example problems.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A wastewater plant with a trickling filter

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 6-25 - 6-35.

   A description is provided of the daily operation problems, proper maintenance, and safety for the trickling filter.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 55-58.

   A few of the same operation problems are mentioned in this reference also, but it would be helpful to read it for additional information.

CLASSIFICATION OF TRICKLING FILTERS

UNIT CONCEPT: Filters are classified as to the volume of liquid, organic loading and flow patterns of the plant.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Identify the three general classifications of trickling filters.
2. Explain the differences between standard-rate and high-rate filters.
3. Determine the hydraulic loading of a trickling filter.
4. Determine the BOD loading on a standard-rate trickling filter.

B. INSTRUCTIONAL AREAS

1. Filter classification

   a. Standard-rate filters

      (1) Hydraulic loading range of 25 to 100 gal./day/sq.ft.
      (2) BOD loading of 5 to 25 lb./day/1,000 cu. ft.
      (3) Six to 8 feet of filter media
      (4) Effluent BOD has a low of 20 to 50 mg./l.

   b. High-rate filters

      (1) Hydraulic loading range 100 to 1,000 gal./day/sq. ft.
      (2) BOD loading of 25 to 300 lb./day/1,000 cu. ft.
      (3) Three to 5 feet of filter media
      (4) Effluent BOD has a low of 20 to 50 mg./l.

   c. Roughing filter

      (1) BOD loading of 300 lb. plus/day/1,000 cu. ft.
      (2) 50-70% BOD removal

- (3) An intermediate filter used to reduce the organic loads for subsequent oxidation processes

d. Filter staging

- (1) Smaller plants require only one filter.
- (2) In slightly overloaded plants, recirculation improves the effluent.
- (3) Two-stage filter plants
  - (a) Two filters operated in series
  - (b) A secondary clarifier between the two filters
  - (c) Recirculation is used.

2. Loading parameters

a. Typical loading rates

- (1) Standard-rate filter
  - (a) Six to 8 feet media
  - (b) Twenty-five to 100 gal./day/sq. ft. hydraulic loading
  - (c) Five to 25 lb. BOD/1,000 cu. ft.
- (2) High-rate filter
  - (a) Three to 5 feet media
  - (b) One hundred to 1,000 gal./day/sq. ft. hydraulic loading
  - (c) Twenty-five to 300 lb. BOD/1,000 cu. ft.

b. Computing hydraulic loading

$$\text{Hydraulic loading gpd./sq. ft.} = \frac{\text{Flow rate, gpd.}}{\text{Surface area, sq. ft.}}$$

c. Computing BOD loading

$$\frac{\text{Organic BOD loading}}{\text{lb. BOD/day/1,000 cu. ft.}} = \frac{\text{BOD applied, lb. BOD/day}}{\text{Volume of media (in 1,000 cu. ft.)}}$$

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Make drawings to show recirculation patterns of a trickling filter.

2. Determine the hydraulic loading and the BOD loading of a trickling filter in a nearby plant. You must first know the flow rate (gpd.) and surface area (sq. ft.) to determine the hydraulic loading. The BOD applied (lb./day) and the volume of media in 1,000 cu. ft. must be known to determine the BOD loading.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

By the use of sketches, each student should identify the different types of trickling filters and explain their differences. From the use of information on the classification and specifications of a specfic trickling filter, the student should answer within 90% accuracy:

1. The amount of hydraulic loading in gallons per day per square feet

2. The amount of BOD loading in pounds per day.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Data related to the dimensions and operation of a trickling filter.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 6-37 - 6-58.

   This reference describes different types of filters and methods of determining the loading parameters.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 52-55.

   Additional filters are considered in this reference as well as diagrams of their operation.

ACTIVATED SLUDGE I

UNIT CONCEPT: It is essential to stabilize and remove dissolved and suspended solids to prevent the waste from causing a nuisance or odors.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Describe the purpose of the activated sludge process in treating wastewater.
2. Explain why air is needed in the activated sludge process and identify the factors which could cause an unsuitable environment in the process.
3. Identify the problems which affect the activated sludge plant because of the collection system or excessive storm water.
4. Prepare a daily plant record report for the activated sludge area.
5. Calculate the sludge age in the activated sludge plant.

B. INSTRUCTIONAL AREAS

1. Requirements for control of the activated sludge process:
    - a. Effluent quality requirements
    - b. Wastewater flow, concentration, and composition
    - c. Maintain a relative amount of activated sludge.
    - d. Stabilize and maintain a satisfactory oxygen level.
    - e. Equal division of plant flow and waste load between treatment units
    - f. Transfer of the pollutional material and solids from the wastewater

   g. Effective control and disposal of inplant residues

   h. Maintain a suitable environment for the living organisms.

2. Variables in collection system

   a. Combined sewer system problems during storms

      (1) Reduced treatment time
      (2) Increased grit and silt
      (3) Increased organic load
      (4) Rapid changes in wastewater temperature and solids content

   b. Waste dischargers to the system - industrial cooperation in notification of undesirable waste discharges

   c. Notice of maintenance of the collection system

3. Operational variables that change

   a. Change in influent BOD load

   b. Change in waste characteristics

   c. Unsuitable concentration of mixed liquor and suspended solids in the aerator

   d. Lower or higher rate of wasting activated sludge

   e. Unsuitable ratio of returning sludge to the aerator

   f. Concentration of solids is too high from the digester, supernatant returned to the plant flow.

   g. Low oxygen concentration in the aerator

4. Daily plant record needed

   a. Suspended solids and volatile content

   b. BOD, COD or TOC

   c. Dissolved oxygen

d. Settleable solids

e. Temperature

f. pH

g. Clarity or turbidity

h. Chlorine demand

i. Coliform group bacteria

j. Meter readings and calculations

5. Typical lab results - used as a guide to determine the performance of a specific plant

6. Design variables

a. Aeration methods

(1) Mechanical aeration
(2) Diffused aeration

b. Activated sludge process

(1) High-rise - sludge age of 0.5 - 2.0 days
(2) Conventional - sludge age of 3.5 - 7.0 days

c. Extended aeration - sludge age of 10 days plus

d. $$\text{Sludge age (days)} = \frac{\text{Suspended solids under aeration (lb.)}}{\text{Suspended solids added (lb./day)}}$$

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. The student should complete a daily record report for the activated sludge area and compare the laboratory results with those of the guide. He should discuss the results with an operator and determine if they can be improved.

2. Calculate the sludge age in the activated sludge plant.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to identify the purpose of the activated sludge process and the importance of air in the process. He must also complete a daily plant record report, identify any operation changes needed, and calculate the age of the sludge. Problems from the collection system or excessive storm water should be identified.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A wastewater plant which has an activated sludge area

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 7-1 - 7-29.

   The requirements for the control of the activated sludge process are listed as well as variables encountered from the collection system and from the plant operation. A list of the daily plant records is provided as well as the typical lab results. The reference also includes design variables which can be considered.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 58-69.

   A good description of the activated sludge process is presented which could be used as a review for the students.

ACTIVATED SLUDGE II

UNIT CONCEPT: For the activated sludge equipment, such as the aerator and clarifiers, to be effective, it must be properly installed, put into operation, and maintained.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Assist the operator in checking the equipment and structures of the aerator.
2. Use the proper procedures for starting, operating, and stopping equipment according to the operator's manual.
3. Observe the necessary safety precautions when working on center "Y" walls of the aeration tank.
4. Assist the operator in checking the equipment and structures of the circular clarifiers and the return sludge and waste sludge pumps.
5. Assist the operator with the start-up procedures of the aeration tanks and the clarifiers.
6. Calculate the pounds of solids in the aeration tank.

B. INSTRUCTIONAL AREAS

1. Aerator
    a. Control gates
        (1) Open and close gates.
        (2) Check for ease of operation and access.
    b. Mud valves
        (1) Open and close each valve.
        (2) Coat stem with heavy-duty waterproof grease.
    c. Weirs
        (1) Use surveyor's level to be sure it is level.
        (2) Check to see if point coating is adequate.

d. Movable gates

  (1) Check the guide slots.
  (2) Be sure the gate seats and operates properly.

e. Water sprays for froth control

  (1) Check nozzle in each spray head.
  (2) Check for leakage in the piping system.
  (3) Check valve at the dead-end of pipeline.

f. Air system

  (1) Air filters

    (a) Check for a tight seal for access doors or hatches.
    (b) Check filter chamber for cleanliness and debris.
    (c) Check filter bags to be sure they are securely installed.
    (d) Check manometer to see that lines are clear and fittings are tight.

  (2) Blowers (compressors)

    (a) Read the manufacturer's manual.
    (b) Prepare a list of items to be checked for the starting and stopping procedures.
    (c) Start unit without a load.
    (d) Check the driver (electric motor) for alignment.
    (e) Check flexible coupling on air lines.
    (f) Manually check the air relief valve.
    (g) Check pressure gauge on the discharge side for air leaks and readability.
    (h) Check the orifice plate.
    (i) Check the condensation trap.
    (j) Check the air main for leaks.

  (3) Air headers

    (a) Check hoist to be sure it fits each header.
    (b) Inspect each air header valve for proper operation.
    (c) Safety precautions to observe when working on center "Y" walls
    (d) Remove debris from tank bottom.

- (e) Check cross-bar of air headers to see that they are perfectly level.
- (f) Flush pipe with water.

(4) Diffusers

- (a) Flush pipe with water before installing diffusers.
- (b) Apply grease to threads of diffusers.

(5) Blower testing

- (a) Start blower and discharge the air directly into the atmosphere.
- (b) Allow it to run for three or four hours and check for vibrations and heating problems.
- (c) Check amperage readings.

2. Secondary clarifiers

   a. Check control gates.

   b. Check clarifier tank for sand and debris.

   c. Collector drive mechanism must have lubrication, drive alignment and complete assembly.

   d. Squeegee blades need the proper distance from the tank floor.

   e. Connecting lines between the aerator and clarifier must be free of debris.

   f. Check pump suction line and controls.

   g. Check levelness of inlet and discharge.

   h. Check scum control mechanism.

3. Return sludge and waste sludge pumps

   a. Lock out the pump motor at the power panel.

   b. Remove trash from lines to pumps.

   c. Check pump casing, impeller, and shaft.

d. Check pressure gauges on suction and discharge lines and valve operation.

e. Check pump and motor bearings for lubrication and for alignment of the pump and motor.

f. Test the pump and record the pressure gauge reading, amperage reading, and flow meter reading.

g. Be sure the check valve closes and seats when the pump is off.

4. Start-up procedures

a. First day

(1) Start air blowers.
(2) Fill aeration tanks to normal operating depth.
(3) Fill the two secondary clarifiers.
(4) When clarifiers are 3/4 full, start the collector mechanism and return sludge pumps.
(5) When clarifiers begin to overflow, start chlorination of the effluent.
(6) After two or three hours of operation of the aerators, check the DO every two hours until a pattern is established.

b. Second day

(1) Run a 60-minute settleability test.
(2) Ten or 20 ml. will settle, but most will be suspended.

c. Third through fifth day

(1) Maintain the DO and sludge return rates.
(2) Start a sampling program.
(3) Use a garden soil to add organisms.
(4) Use activated sludge from a neighboring treatment plant to add organisms.

d. Sixth day

(1) When checked, effluent should be reasonably clear.
(2) Use the 60-minute settleable solids test.

(3) Calculation of pounds of solids under aeration

Solids, lb. = mixed liquor suspended solids, (mg./l) X aerator volume (MG) X 8.34 lb./gal.

(4) Calculation of the return sludge rate, MGD

Return sludge rate, MGD = aerator flow (MGD) X settleable solids (%)

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. If it is possible, it would be good experience for a student to assist an operator in checking the equipment and structures of a new activated sludge plant before it is put into operation. Since such experience would rarely be available, descriptive plans should be submitted by students describing the checking procedures which would be used.
2. Assist an operator in putting such a plant into operation, or prepare a plan of what procedures would be followed in putting it into operation.
3. Calculate the pounds of solids in an aeration tank of the plant where the student is working.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate or prepare a report of the proper procedures to use in checking the equipment and structures of a new activated sludge area before it is placed in operation. He must follow the proper start-up procedures and safety precautions of the activated sludge area. He must also calculate the pounds of solids in the aeration tank of a given plant.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A wastewater plant with the new activated sludge area.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 7-31 - 7-57.

   A good description is provided on how to check out a new activated sludge plant and the start-up procedures to follow. This information does not seem to be available in other references.

ACTIVATED SLUDGE III

UNIT CONCEPT: Competent operation of aeration equipment and correct use of math to determine such things as sludge age, pounds of solids for aerator, and waste return sludge pumping rate, is required for an efficient activated sludge treatment process.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Calculate the desired number of pounds of solids for the aerator.
2. Calculate the waste return sludge pumping rate.
3. Explain why and where activated sludge is wasted.
4. Assist the operator in the pre-start checking of a small extended aeration plant.
5. Assist the operator in the start-up and operation of a small extended aeration plant.
6. Test a sample from the aeration compartment to determine the condition of the solids.

B. INSTRUCTIONAL AREAS

1. Determination of sludge age - used to indicate when activated sludge should be wasted

   a. Pounds of mixed liquor suspended solids in aerator

   Solids in aerator (lb.) - mixed liquor suspended solids (mg./l) X aerator volume (MG) X 8.34 lb./gal.

   b. Pounds of solids added/day to a system by the primary effluent

   Solids added lb./day = primary effluent suspended solids (mg./l) X flow (MGD) X 8.34 lb./gal.

   c. Calculate sludge age in days

$$\text{Age (days)} = \frac{\text{Suspended solids in aerator (lb.)}}{\text{Suspended solids in primary effluent (lb./day)}}$$

d. Desired pounds of aerator solids to be maintained in the aerator

$$\text{Solids (lbs.)} = \text{Sludge age, days} \times \text{suspended solids in primary effluent (lb./day)}$$

e. Calculation of the desired mixed liquor suspended solids concentration in mg./l

Suspended solids (mg./l) =

$$\frac{\text{Desired suspended solids in aerator (lb.)}}{\text{Volume of aerator (MG)} \times 8.34 \text{ lb./gal.}}$$

2. Wasting activated sludge

   a. Varies from 1% to 20% of total incoming flow but is continuous

   b. Wasting is accomplished by diverting part of the return sludge to a primary clarifier, thickener, aerobic digester, or anaerobic digester.

3. Determination of waste sludge pumping rate

   Pumping rate, MGD =

$$\frac{\text{Solids to be wasted (lb./day)}}{\text{Return sludge concentration (mg./l)} \times 8.34 \text{ lb./gal.}}$$

4. Pre-start check-out

   a. Tank must be level.

   b. Cathodic protection may be required if the tank is metal.

   c. Check the condition of the paint.

   d. Remove rocks and debris.

   e. Check comminutor for lubrication, clearance, and operation.

   f. Check aerator for lubrication, direction of rotation, and the mechanical aerator or the compressor.

g. Record and file the data on:

   (1) Plant model and serial number
   (2) Plant manual
   (3) Name plate data from the equipment

h. Check the operation of the influent gate.

5. Starting the plant

   a. Fill aeration compartment first.

   b. Start aerator and compressor or agitator.

   c. If air lifts are used, keep line closed until the settling compartment is filled.

   d. Control foam with a lawn sprinkler.

6. Operation of aeration equipment

   a. Operate continuously.

   b. Effluent water appearance indicates equipment performance.

      (1) Murky water or a rotten egg odor indicates a need for more air.
      (2) Clear water indicates sufficient air.

7. Wasting sludge

   a. Turn off return pumps for one hour.

   b. Pump 5% of the waste solids into a drying bed by lowering the sludge blanket 5%.

   c. Record the pumping time.

   d. The appearance of the foam and the amount of solids in the effluent indicate the frequency of wasting needed.

8. Operation - daily check:

   a. Appearance of aeration and final clarification compartment

  b. Operation of the aeration unit and lubrication
  c. Operation of the return sludge line
  d. Operation and lubrication of the comminuting device
  e. Hose down aeration tank and final compartment.
  f. Brush weirs when necessary.
  g. Skim the grease and other debris.
  h. Check appearance of the plant discharge for undesirable materials.

9. Laboratory testing
   a. Quart jar sample from aeration compartment
   b. Settle for 30 minutes
   c. Half should be settled solids of chocolate brown color with clear water above it.
   d. If water is murky, a longer aeration period is needed.
   e. If solids fill less than 1/4 jar, the solids level must be increased.
   f. Check DO, pH, and suspended solids if equipment is available.

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. It is important for the student to gain as much experience as possible in the use of math as it relates to the operation of a wastewater plant. Some of this experience can be gained by the student determining sludge age, solids in aerator, and sludge pumping rate.
2. If there is an opportunity, a student should assist in the pre-start of a small extended aeration plant and its start-up.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate the proper procedures to use in a pre-start check, the start-up and the operation of a small extended aeration plant. He must also calculate sludge age, pounds of solids for aerator, and waste return sludge pumping rate for an activated sludge treatment process. The student should define why and where activated sludge is wasted. The student should demonstrate proper procedures in testing samples from the aeration compartment to determine the condition of the solids.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A small extended aeration plant

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 7-59 - 7-77.

   Information is provided for the operational control of the activated sludge treatment process. This is through determination of sludge age and wasting activated sludge. Also the operation of an extended aeration package plant is included.

ACTIVATED SLUDGE IV

UNIT CONCEPT: Accurate record keeping will help in determining corrections that need to be made in the plant's activated sludge process.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain why the plant records of the activated sludge operation are important.
2. Perform the necessary operations to correct an activated sludge plant that has become upset.
3. Calculate the amount of mixed liquor volatile suspended solids (MLVSS) to be maintained in the aerator.
4. Determine the mean cell residence time (MCRT) for solids control.
5. Explain the differences in the conventional activated sludge process and the Kraus process, the step-feed aeration process, and the complete mix process.

B. INSTRUCTIONAL AREAS

1. Typical problems of an activated sludge plant
    a. Handling shock loads
    b. Handling a build up of mixed liquor suspended solids
2. Items to check when plant becomes upset:
    a. Changes made in other plant units
    b. Changes in daily flows and waste concentrations
    c. Significant temperature changes of the influent
    d. Changes in the sampling program
3. Samples of plant problems

   a. High solids content in digester supernatant

   b. Flow or waste changes

   c. Temperature changes

   d. Wide variation in lab results

4. Preventing sludge bulking

5. Controlling septic sludge

6. Handling toxic substances

7. Controlling rising sludge

8. Controlling froth

9. Maintaining a favorable food/organism ratio

10. Calculation of food/organism aerator loading

11. Mean cell residence time (MCRT)

12. Contact stabilization process

13. Kraus process

14. Step-feed aeration process

15. Complete mix process

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Assist an operator in locating and correcting problems with an activated sludge plant.

2. Calculate the MLVSS for the aerator and the MCRT for the activated sludge process using data from the plant report where you work.

3. Diagram a contact stabilization plant, the Kraus process, and the step aeration process.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate the use of plant records in correcting problems in the activated sludge area and make the necessary plant corrections. He must also properly calculate the MLVSS for the aerator and the MCRT for the activated sludge process. The student must diagram and explain the contact stabilization process, the Kraus process, and the step aeration process.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A wastewater plant with an activated sludge area

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 7-79 - 7-111.

   Information is provided relating to the problems of an activated sludge plant, the aerator leading parameters, and the modifications of the activated sludge process.

SLUDGE DIGESTION AND HANDLING I

UNIT CONCEPT: Proper operations with the digestion and handling of sludge are essential to protect the receiving water from pollution.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain the purpose of a sludge digester and how it operates.
2. Draw and identify fourteen major components of a digester and gas system.
3. Check the gas system for proper operation by assisting an operator.

B. INSTRUCTIONAL AREAS

1. Purpose of sludge digestion
2. How sludge digestion works
3. Components of the anaerobic sludge digester and their operation
    - a. Pipelines and valves
    - b. Digester
4. Gas system - removal of gas from digester to point of use
    - a. Gas dome
    - b. Pressure relief and vacuum relief valves
    - c. Flame arrestors
    - d. Thermal valves
    - e. Sediment trap

  - f. Drip traps - condensate traps
  - g. Gas meters
  - h. Manometers
  - i. Pressure regulators
  - j. Waste gas burner
- 5. Purpose and operation of sampling well
- 6. Purpose and operation of digester heating
- 7. Purpose and operation of digester mixing
- 8. Purpose and operation of gas mixing
- 9. Purpose and operation of mechanical mixing
  - a. Propeller mixers
  - b. Draft tube propeller mixers
  - c. Pumps

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Draw and identify the parts of a digestion tank.
2. Check the pressure relief valve and the vacuum relief valve with the assistance of an operator.
3. Check the thermal valves and service the flame arrester with the assistance of an operator.
4. Adjust the gas pressure of the digester gas system.
5. Maintain the proper digester mixing and break up the scum blanket.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to explain the construction and operation of a sludge digester and gas system. He must check valves for proper operation and maintain the digester mixes. He must be able to either draw, or identify from drawings, fourteen or more major components of a digester and gas system.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A sludge digester and a gas system is needed for student activities to enable the student to achieve a working knowledge of their operation.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 8-1 - 8-45.

   A discussion is presented of the purpose of sludge digestion and the components of an anaerobic sludge digester.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 85-93.

   A good, detailed discussion of the digester is provided.

SLUDGE DIGESTION AND HANDLING II

UNIT CONCEPT: Competent operation and prevention of problems in digesters, sludge handling equipment, and incinerators will make the sludge disposal process more efficient.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Start and operate a new digester for the production of methane gas low in CO_2 while using the assistance of an operator.
2. Prepare and operate a sludge drying bed which will dry sludge in four weeks without causing odors.
3. Operate a vacuum filter or a centrifuge to produce a high quality cake.
4. Operate a furnace for the incineration of sludge and maintain a temperature of 1250° to 1400° F.

B. INSTRUCTIONAL AREAS

1. Operation of digesters
   - a. Raw sludge and scum
   - b. Starting a digester
   - c. Feeding
   - d. Neutralizing a sour digester
   - e. Enzymes
   - f. Foaming problems
   - g. Gas production
   - h. Supernatant and solids
     - (1) Primary digester
     - (2) Secondary digester

- i. Rate of sludge withdrawal

2. Digester sludge handling - types and advantages
   - a. Sludge drying beds - sand
   - b. Blacktop drying beds
   - c. Sludge lagoons
   - d. Withdrawal to land
   - e. Mechanical dewatering
     - (1) Vacuum filters
     - (2) Centrifuge
   - f. Incinerating sludge

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. The student should assist an operator in starting and operating a new digester. He should demonstrate his awareness of handling problems with the digester.
2. He should prepare the sand or blacktop drying bed and properly fill the bed with sludge.
3. Draw and identify the parts of a sludge drying bed.
4. Properly dispose of sludge on land.
5. Operate a vacuum filter or a centrifuge.
6. Operate a furnace for the incineration of sludge.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to start and/or operate a digester, identify and/or prevent digester problems, and dry the sludge with the means available. He must demonstrate his ability to operate a vacuum filter or centrifuge and produce a high quality cake. He must also demonstrate his ability to operate a furnace and maintain a temperature of 1250° to 1400° F. while incinerating the sludge.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. A new sludge digester
2. Sand or blacktop drying bed
3. Land disposal operation for sludge
4. Vacuum filter or centrifuge
5. Sludge incineration furnace

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 8-47 - 8-81.

   A description is provided concerning the operation of digesters and the handling of sludge.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 93-115.

   Further information is provided on sludge treatment methods and sludge disposal as well as the use of sludge gas. This chapter also includes incineration which is not covered in the other reference.

SLUDGE DIGESTION AND HANDLING III

UNIT CONCEPT: Competent laboratory testing of sludge digester samples and test interpretation along with regularly scheduled operational checks will help keep the digester in good working condition.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Perform the laboratory tests relating to sludge digestion and achieve the same results as the operator performing the analyses.
2. Perform the calculations necessary for the operation of the sludge digester.
3. Perform the periodic operational checks necessary to keep the digester in good working condition.

B. INSTRUCTIONAL AREAS

1. Digester controls and test interpretation
    - a. Temperature
    - b. Volatile acid/alkalinity relationships
    - c. Digester gas
    - d. pH
    - e. Solids test
    - f. Volume of sludge
    - g. Raw sludge
    - h. Recirculated sludge
    - i. Digester supernatant
    - j. Computing digester loading
    - k. Computing gas production

- l. Solids balance

2. Operational checks and sampling schedule
   - a. Daily
   - b. Weekly
   - c. Monthly
   - d. Quarterly
   - e. Semiannually
   - f. Three to eight years
3. Digester sampling schedule
   - a. Daily
   - b. Twice weekly
   - c. Weekly
   - d. Monthly to quarterly
4. Aerobic sludge digestion
   - a. Characteristics
   - b. Process description
   - c. Operation of three aerobic digesters
   - d. Operational records
     - (1) Daily
     - (2) Weekly
     - (3) After sludge withdrawal
5. Operational problems
6. Maintenance problems

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Using the procedures outlined in Chapter 14 of the "Sacramento Manual," determine the volatile acid/alkalinity relationship, the CO_2 content in the digester gas, the pH, and the total and volatile solids of sludge digester samples.

2. Calculate the following:

   a. Volume of sludge pumped/day

   b. Pounds of dry sludge handled

   c. Percent reduction of volatile solids

   d. Digester loading

   e. Gas production

   f. Solids balance

3. Make the necessary checks needed to keep the digester in good working condition.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to determine the volatile acid/alkalinity relationship, the CO_2 in digester gas, the pH, and the total and volatile solids of sludge digester samples. He must also calculate the volume of sludge pumped/day, pounds of dry sludge handled, percent reduction of volatile solids, digester loading, gas production, and solids balance. He must also make the necessary operational checks of the digester and he must explain the operation of an aerobic digester plant. These should be done to the satisfaction of the plant supervisor.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Laboratory equipment and facilities as outlined in Chapter 14 of the "Sacramento Manual" for the laboratory tests included in this lesson

2. A sludge digester which the student can use to assist the operator perform the operational checks necessary for proper operation

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 8-83 - 8-115, 14-1 - 14-239.

   This reference includes digester controls and test interpretation, operational checks and sampling schedule, and aerobic sludge digestion. There are many mathematical calculations included as a part of test interpretation that are important for the student to perform.

WASTE TREATMENT PONDS I

UNIT CONCEPT: It is essential that the proper procedures are used in operating shallow ponds for the treatment or stabilization of wastewater by the natural processes of algae and bacteria.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Identify the advantages of using ponds to treat wastewater and their classification.
2. Start in operation, with the assistance of an operator, a waste treatment pond that does not produce odors.
3. Perform the daily operations and maintenance duties required for proper pond waste treatment with the assistance of an operator.

B. INSTRUCTIONAL AREAS

1. Advantages of using ponds for wastewater treatment
2. Pond classifications and uses
3. Treatment process of facultative ponds
4. Pond performance
5. Starting the pond
6. Daily operation and maintenance
   a. Scum control
   b. Odor control
   c. Weed control

   d. Insect control

   e. Levee maintenance

   f. Headworks and screening

   g. Operating hints

7. Surface aerator operation

8. Sampling and analysis of the pond

   a. Frequency and location of lab samples

   b. Expected treatment efficiencies

9. Safety in pond operation

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Start a waste treatment pond. This may be possible by working with a farmer in your area who is interested in using the pond as a means of livestock waste disposal.

2. Conduct the daily operation and maintenance duties required to prevent the development of odors and to maintain a low BOD.

3. Perform the necessary sampling and analysis to determine the performance of the pond using the procedures outlined in Chapter 14 of the "Sacramento Manual."

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to identify the advantages, classifications, and factors relating to ponds and their operating efficiency. He must also start a waste treatment pond, conduct daily operation and maintenance duties, and sample and analyze the pond operation.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. A waste treatment pond being developed and/or in operation.

2. The equipment needed for determining pH, BOD, DO, coliform, solids, and temperature included in Chapter 14 of the "Sacramento Manual"

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 9-1 - 9-29, 14-1 - 14-239.

   This reference considers in detail the development and operation of waste treatment ponds. This type of treatment is suitable only for small communities and is more commonly used in the South.

WASTE TREATMENT PONDS II

UNIT CONCEPT: Proper waste treatment pond design including the inlets and outlets, levee, and depth is necessary for effective treatment of waste by ponding.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Determine the feasibility of treating a specific waste by ponding, and design a waste treatment pond.
2. Calculate the detention time, organic loading, population loading, and hydraulic loading of a given pond after collecting the needed information from the pond.

B. INSTRUCTIONAL AREAS

1. Location of treatment ponds
2. Chemistry of waste influent
3. Headworks and screening for removal of large objects
4. Purpose of measuring flow
5. Inlet and outlet structure design
6. Design of levee slopes
7. Desirable pond depths
8. Pond loading determination

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Draw plans for a waste treatment pond to serve a given size community, and label the parts.
2. Calculate the detention time, organic loading, and hydraulic loading of the pond.
3. Use an aquarium placed in sunlight to determine the feasibility of treating specific wastes by ponding.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to determine the feasibility of treating specific wastes by ponding. He must also identify the proper design of a pond with a drawing and calculate the detention time, organic loading, population loading, and hydraulic loading of such a pond.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A visit to a treatment pond could assist the students' understanding of the design criteria if such data could be made available to the students at that time.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 9-31 - 9-49.

   A discussion is provided on the common design criteria which should assist the student in the development and operation of a waste treatment pond.

DISINFECTION AND CHLORINATION I

UNIT CONCEPT: Treated wastewater must be disinfected by the operator using the recommended procedures to destroy pathogenic organisms before it can be discharged into receiving waters.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Explain the purpose of disinfecting wastewater and how it can be accomplished.
2. Perform the calculations necessary for the proper chlorination of wastewater using the chlorination control nomogram.

B. INSTRUCTIONAL AREAS

1. Principles of wastewater disinfection with chlorine
    a. Purposes of disinfection of wastewater
    b. Reaction of chlorine in wastewater
    c. Rules of disinfection
        (1) Reasons for MPN[4] variations in chlorinated wastewater samples
        (2) Improving chlorination effectiveness
    d. Chlorine requirement
2. Points of chlorine application
    a. Collection system chlorination
    b. Prechlorination
    c. Plant chlorination

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[4] MPN is the Most Probable Number of coliform group organisms per unit volume expressed as density of organisms per 100 ml.

   d. Postchlorination

3. Chlorination process control

   a. Chlorinator control

      (1) Manual c[illegible]
      (2) Start-[illegible]
      (3) Step-r[illegible]
      (4) Timed p[illegible]trol
      (5) Flow proportional control
      (6) Chlorine residual control
      (7) Compound loop control

   b. Chlorination control nomogram

   c. Hypochlorinator feed rate

4. Chlorine distribution

   a. Solution discharge lines

   b. Chlorine solution diffusors

   c. Mixing

5. Measurement of chlorine residual

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Calculate the feed rate of chlorine using a nomogram when given the maximum flow rate and the chlorine dosage of a wastewater plant.

2. Calculate the number of pounds of HTH (high test hypochlorite) needed per day when given the flow and the chlorine dosage.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to define the purposes of disinfecting wastewater and how it can be accomplished. He must also calculate feed rates of chlorine using a nomogram and also using hypochlorites when given flow rates and chlorine dosage needed. Sample questions to be answered could be:

1. The purpose of disinfection and why it is important
2. How pathogenic bacteria are destroyed or removed from water
3. Why chlorination is used for disinfection
4. Why wastes are not sterilized

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Data concerning flow rates and chlorine dosages used in wastewater plants

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 10-1 - 10-30.

   General information is provided concerning the use of chlorine to disinfect wastewater, where it should be applied in the treatment process, and how the amount applied can be controlled. The use of the nomogram is explained. Determination of feed rates for hypochlorites, application of chlorine, and measurement of chlorine residuals are included.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 73-83.

   This reference includes many details which were not included in the "Sacramento Manual" and it would be useful as a review.

DISINFECTION AND CHLORINATION II

UNIT CONCEPT: Proper handling of chlorine and competent operation and maintenance of chlorination equipment will result in the correct amount of chlorine added to the wastewater and safety for the plant employees.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Use the proper safety precautions when handling chlorine.
2. Change chlorine containers and check for chlorine leaks with the assistance of an operator.
3. Check and perform the necessary maintenance operations on the chlorine equipment with the assistance of an operator.

B. INSTRUCTIONAL AREAS

1. Safety and first aid
    - a. Chlorine hazards
    - b. Importance of care in handling chlorine
    - c. Methods of protection from chlorine hazards
    - d. First aid measures
2. Chlorine handling
    - a. Chlorine containers
        - (1) Cylinders
        - (2) Ton tanks
        - (3) Chlorine tank cars
    - b. Removing chlorine from containers
        - (1) Connections

    - (2) Valves
    - (3) Ton tanks
    - (4) Chlorine leaks

3. Chlorination equipment and maintenance

   a. Chlorinators

      - (1) Vacuum - solution feed chlorinators
      - (2) Partial vacuum, pressure types, and pulsating type chlorinators

   b. Hypochlorinators

   c. Installation, operation, and maintenance

   d. Installation requirements:

      - (1) Piping, valves, and manifolds
      - (2) Chlorinator injector water supply

4. Other uses of chlorine

   a. Odor control

   b. Protection of structures

   c. Aid to treatment

      - (1) Sedimentation
      - (2) Trickling filters
      - (3) Activated sludge
      - (4) Reduction of BOD

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. It is important that the student receive experience in the use of a self-contained breathing apparatus to the point where it is a routine practice. The fire department can be of help in providing such training.

2. Assist an operator in changing the chlorine containers and checking for chlorine leaks, and in performing the necessary maintenance operations on the chlorine equipment.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to use proper safety precautions when handling chlorine, changing chlorine containers and checking for leaks, and performing the general maintenance operations on the chlorine equipment. He should be able to give information such as:

1. The hazards of chlorine gas
2. Recommended breathing apparatus to use when repairing a chlorine leak
3. First aid measures to be taken if a person comes into contact with chlorine
4. How the rate of chlorine flow in a chlorinator is controlled

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. A self-contained breathing apparatus
2. Chlorinator facilities in a wastewater plant

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 10-33 - 10-69.

   The hazards in using chlorine are considered in detail, plus recommendations for protecting yourself and first aid measures to use. Information is also provided concerning the chlorination equipment and its maintenance.

MAINTENANCE OF TREATMENT PLANT

UNIT CONCEPT: It is essential that a scheduled maintenance program be carried out to keep the equipment in an operating condition that will maintain the quality of effluent discharged by the plant.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Perform the needed maintenance on buildings and grounds.
2. Perform the needed general and preventive maintenance on pumps, drives, valves, and flow meters.
3. Unplug pipes, pumps, and valves using the recommended methods.

B. INSTRUCTIONAL AREAS

1. Treatment plant maintenance - general program
    a. Maintaining preventive maintenance records
    b. Scheduling building maintenance regularly
    c. Determining schedule for draining and inspecting tanks and channels
    d. Maintaining plant grounds
    e. Maintaining chlorinators
2. Mechanical maintenance
    a. General maintenance of:
        (1) Pumps
        (2) Controls

b. Preventive maintenance of:

  (1) Pumps
  (2) Drives
  (3) Valves

3. Maintenance of flow meters

  a. Use and maintenance of flow measurement equipment

  b. Responsibilities of manufacturer and operator for equipment

  c. Various devices for flow measurement

  d. Meter location

  e. Conversion and readout instruments which control operation

  f. Sensor maintenance

  g. Conversion and readout instrument maintenance

4. Unplugging pipes, pumps and valves

  a. Plugged pipelines

  b. Scum lines

  c. Sludge lines

  d. Digested sludge lines

  e. Plugging pipelines

    (1) Pressure methods
    (2) Cutting tools
    (3) Hydraulic nozzle pressure unit
    (4) Last resort - dismantle plugged section

  f. Plugged pumps and valves

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. The student should assist the operator in performing the periodic maintenance on buildings and equipment.

2. Each student should disassemble a centrifugal pump, clean it, identify the parts by name, repack the glands, reassemble the pump and check it for proper operation and output.

3. Each student should disassemble an electric motor, clean it, identify the parts by name, lubricate it properly, reassemble it, and check it for proper operation.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to perform general and preventive maintenance on buildings, grounds, and equipment. Evaluation items should include:

1. Why a good maintenance program for the treatment plant should be planned

2. The difference between an equipment service card and a service record card

3. Items which should be included in a building maintenance program

4. When inspection and maintenance of the underwater portions of plant structures such as clarifiers and digesters should be scheduled

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Shop area

2. Hand tools

3. Centrifugal pumps

4. Electric motors

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 11-1 - 11-97.

A very complete discussion is provided on the maintenance of the treatment plant buildings, facilities, and equipment. Detailed diagrams are provided of the wastewater pumps as well as an extensive listing of the necessary equipment maintenance and the frequency needed.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 157-168.

A short presentation is given on the maintenance of the plant and equipment without the detail of the "Sacramento Manual." It should be checked for the points which are not included in the other.

PLANT SAFETY AND GOOD HOUSEKEEPING

UNIT CONCEPT: It is important that all plant workers think safety, as accidents are usually caused by indifference, neglect, bad supervision and/or poor design and arrangement of equipment and facilities.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Identify the safety hazards of the equipment and facilities.
2. Demonstrate the proper use of rescue equipment, first aid techniques, and fire control equipment.
3. Demonstrate rational reactions in role-playing emergency situations.
4. When presented with simulated emergency situations which are possible to occur in the plant operation, describe and demonstrate procedures for coping with the problem.

B. INSTRUCTIONAL AREAS

1. Kinds of general hazards
    - a. Physical injuries
    - b. Infections and infectious diseases
    - c. Oxygen deficiency in enclosed areas
    - d. Toxic, suffocating gases, or vapors
    - e. Radiological hazards
    - f. Explosive gas mixtures
    - g. Fire

h. Electrical shock

i. Noise

2. Specific hazards

   a. Collection systems

      (1) Protection at manholes
      (2) Shoring of excavations
      (3) Training needed for the operation of sewer cleaning equipment
      (4) Warnings needed for traffic hazards

   b. Treatment plants and pumping stations

      (1) Headworks
      (2) Grit chambers
      (3) Clarifiers or sedimentation basins
      (4) Digesters and digestion equipment
      (5) Trickling filters
      (6) Aerators
      (7) Ponds
      (8) Chlorine
      (9) Applying protective coating
      (10) Housekeeping

3. Safety in the laboratory

   a. Collecting samples

   b. Equipment set-up and performance of tests

4. Fire prevention and control

   a. Ingredients necessary for a fire

   b. Fire control methods and equipment

   c. Fire prevention practices

5. Water supplies and potential cross-connections

6. Safety equipment and their operation

7. Periodic safety meetings

8. Hazard areas to avoid in tours of a facility

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Invite the fire department to demonstrate methods of artificial respiration and other rescue operations.

2. Conduct some role-playing exercises in which the student is placed in an emergency situation and must decide the best possible action from a given set of alternatives.

3. Make a tour of the wastewater treatment plant and identify the locations of emergency equipment and be sure students can operate the equipment properly.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate the proper use of artificial respirators, chlorine gas masks, fire extinguishers, first aid techniques, and the proper methods of lifting. He must identify the safety hazards of the job and demonstrate rational reactions in role-playing emergency situations. Example evaluation items might include:

1. What the operator should do when he discovers an area with an oxygen deficiency

2. Parts of equipment which should have guards installed around them

3. Why a tray should be placed under the working area during mercury clean-up

4. Why safety equipment should be checked periodically

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Appropriate emergency equipment.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 12-1 - 12-51.

   A complete description is provided on the hazards of working in a wastewater treatment plant and how to avoid accidents.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 169-182.

   As safety cannot be overemphasized, the additional reading found in this reference may reinforce much of what was learned from the other reference. Also, there is a resuscitation section on page 178 which is not in the other reference, but is important when working around water, gases, and electricity.

SAMPLING RECEIVING WATERS

UNIT CONCEPT: To prevent the wastewater from interfering with the uses of receiving, it is necessary to measure and record the effect of the plant effluent on the receiving waters.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

Using adequate safety precautions, collect samples which represent the condition of the water at each sampling station and preserve the samples so they do not change before the final analysis is completed.

B. INSTRUCTIONAL AREAS

1. Purpose of sampling receiving waters
2. Selection of representative samples
    a. Temperature measurement
    b. Dissolved oxygen measurement
    c. Review of sampling results to determine if results are meaningful
3. Collection techniques
    a. Frequency of sampling
    b. Size of sample
    c. Labeling of samples
4. Safety in sampling
5. Sampling other types of receiving waters

6. Characteristics to measure from the samples

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

Assist an operator in collecting samples which represent the condition of the water and properly preserve the samples to prevent them from changing before the final analysis is completed. See Chapter 14, pages 14-21 - 14-35 of the "Sacramento Manual."

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must be able to collect comparable samples to those which the operator collects. Evaluation should also determine the student's understanding of items such as:

1. Why receiving waters should be sampled
2. What a sample label should include
3. What the term "representative sample" means

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Sampling bucket for eight foot handle
2. Sampling bottles

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 13-1 - 13-21, 14-21 - 14-35.

   The content is limited to the sampling of receiving waters in Chapter 13; sampling of the areas of a treatment plant is referred to in chapters considering the different plant areas.

LABORATORY PROCEDURES AND CHEMISTRY

UNIT CONCEPT: It is essential to have a knowledge of laboratory procedures and chemistry if one is to understand and control the treatment of wastewater, and measure the effectiveness of such treatment.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Practice proper safety and hygiene habits in the laboratory.
2. Collect and preserve representative samples for laboratory analysis from the treatment plant.
3. Perform the recommended plant control tests needed to maintain the desired effluent quality and achieve the same results as the operator.

B. INSTRUCTIONAL AREAS

1. Safety and hygiene
    a. Laboratory safety
    b. Personal hygiene for plant personnel
2. Sampling
    a. Importance of the sample being representative
    b. Accuracy of laboratory equipment
    c. Selection of sampling point for a representative sample
    d. Time of sampling
    e. Compositing and preservation of samples

   - f. Sludge sampling
   - g. Sampling devices

3. Recording results on a laboratory work sheet

4. Types of plant control tests
   - a. Total alkalinity
   - b. Biochemical oxygen demand (BOD)
   - c. Carbon dioxide (CO_2) in digester gas
   - d. Chemical oxygen demand (COD)
   - e. Chlorine residual
   - f. Clarity or turbidity
   - g. Coliform group bacteria
   - h. Dissolved oxygen (DO)
   - i. Hydrogen sulfide (H_2S)
   - j. pH
   - k. Settleability of activated sludge solids
   - l. Settleable solids
   - m. Sludge age
   - n. Digested sludge dewatering characteristics
   - o. Supernatant graduate evaluation
   - p. Suspended solids
   - q. Temperature
   - r. Total and volatile solids
   - s. Volatile acids

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Assist an operator in collecting and preserving representative samples to be analyzed in the school laboratory and/or in the wastewater laboratory.

2. Perform as many of the recommended plant control tests as the student's ability allows.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must be able to collect and preserve representative samples while using proper safety and hygiene habits. He must also be able to perform the basic plant control tests in the laboratory.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

The recommended general laboratory supplies are listed in Chapter 14, pages 215-219, in the "Sacramento Manual."

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 14-1 - 14-219.

   The laboratory tests are written in a very understandable way for the student with the step by step procedures outlined. A list of the recommended general laboratory supplies needed is also included.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 221-233.

   This reference gives much more emphasis on the chemical symbols of the elements and the formulas of the compounds. It is important that the students become familiar with the symbols that identify the chemicals which they use in the laboratory.

BASIC MATHEMATICS
AND TREATMENT PLANT PROBLEMS

UNIT CONCEPT: Many processes in the wastewater treatment plant require the use of mathematics in the control of the treatment in order to produce an acceptable effluent.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Demonstrate his ability to work mathematical operations using whole numbers, decimals and fractions.
2. Calculate solutions correctly using squares, cubes, roots, averages, areas and volumes with problems related to the wastewater treatment plant.
3. Convert measurements of the English system to the metric system.
4. Determine weight-volume relations, pressure, and velocity using problems related to wastewater treatment.
5. Properly demonstrate the use of the six steps in solving problems (see B.12. following).

B. INSTRUCTIONAL AREAS

1. Using whole numbers and decimals to determine flow rate, tank volume, and detention time
    a. Addition
    b. Subtraction
    c. Multiplication
    d. Division
2. Using fractions to determine detention time, plant efficiency

   a. Improper fractions

   b. Reducing fractions

   c. Adding, subtracting, multiplication and division

   d. Decimal fractions

   e. Percentage

   f. Ratio and proportion

3. Using squares, cubes, and roots to determine surface area of tanks and tank capacities

4. Using averages and median to determine BOD's and coliform for a week's time

5. Determining the area of a settling basin

6. Determining the volume of a cylinder tank

7. Using the metric system to determine the BOD of a plant

8. Determining the weight-volume relations of water

9. Determining the force, pressure, and head of water in a tank

10. Determining velocity and rate of flow to determine the speed of water movement in a pipe

11. Using pump calculations to determine the capacity of a pump

12. Steps to use in solving problems

    a. Identify problem

    b. Selection of formula

    c. Units and dimensional analysis determinations

    d. Calculations to use

    e. Number of significant figures needed

f. Checking the results

13. Typical treatment plant problems which require calculation

14. Summary of formulas to use

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

Since both the work of a wastewater treatment operator and the operator's certification examination require a knowledge of basic mathematics, it is important that students receive as many opportunities to practice their math calculations as possible. The typical treatment problems on pages 15-77 to 15-91 in the "Sacramento Manual" are a source of the type of problems with which the student should be familiar.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must demonstrate his ability to properly perform basic math skills and use them to solve typical treatment plant math problems. A minimum level of accuracy should be established for each application of math problems. An example math evaluation:

A grit chamber removed 3.2 cubic feet of grit during a period when the total flow was 0.8 MG. How many cubic feet are removed per MG?

Known - Volume of grit = 3.2 cu. ft.
Volume of flow = 0.8 MG

Unknown - Grit removed Cu. ft./MG

$$\text{Grit removed, cu.ft./MG} = \frac{\text{Volume of grit, cu. ft.}}{\text{Volume of flow, MG}}$$

$$= \frac{3.2 \text{ cu. ft.}}{0.8 \text{ MG}}$$

$$= 4.0 \text{ cu. ft./MG}$$

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

Actual data from a wastewater plant on flow rates, tank volume, detention time, BOD and coliform which the student himself has collected would be ideal.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 15-1 - 15-101.

   Very good, detailed explanations are provided starting with basic math operations and becoming progressively harder. The student should skip the areas in which he already has a mastery and concentrate on the areas that create problems for him.

ANALYSIS AND PRESENTATION OF DATA

UNIT CONCEPT: It is essential to analyze and interpret data to indicate trends, changes in plant operation, or treatment process efficiencies which justify increases needed in the budget of the treatment plant.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Analyze and interpret laboratory results, monometers, gauges, and chart readings of a typical wastewater treatment operation.
2. Prepare tables, graphs and charts which illustrate trends and changes in the treatment plant processes.

B. INSTRUCTIONAL AREAS

1. Causes of variations in plant results
    a. Water or material being examined
    b. Sampling methods
    c. Testing methods
2. Monometer and gauge reading
3. Chart reading
4. Average value determination
5. Range of values determination
6. Median, mode, and geometric mean
7. Determination graph construction
    a. Bar graphs

   b. Trends shown by graphs

8. Variance and standard deviation calculation

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

The student should assist an operator in collecting data from laboratory tests, monometers, gauges, and charts which are used to calculate averages, medians, and modes where appropriate. He should then use a bar graph or line graph to show trends and distribution in the data. If the student has the ability, it would be useful to calculate variance and standard deviations using the data collected.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must be able to analyze and interpret data and prepare tables, graphs, and charts which properly illustrate the trends in the data.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A wastewater treatment plant where data can be collected over a period of time for analysis and interpretation.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 16-1 - 16-37.

   This reference provides important information relating to the analysis and interpretation of data which is collected by the wastewater treatment operator. Simple methods of analyzing data are presented as well as usable ways to illustrate trends over a period of time.

RECORDS AND REPORT WRITING
FOR WASTEWATER TREATMENT OPERATION

UNIT CONCEPT: Well written reports are essential if operators are to communicate with their management and the general public concerning the plant operation and the need for plant improvements and personnel.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Compile complete and accurate operation and/or performance records for one month.

2. Write a well-prepared monthly report which communicates to the management and the public the operation of the wastewater treatment plant.

B. INSTRUCTIONAL AREAS

1. Records

   a. Importance of and need for records

   b. Type of records needed

      (1) Operation reports
      (2) Physical plant and stock inventory records
      (3) Maintenance records
      (4) Financial records
      (5) Personnel records

   c. Frequency of records

   d. Keeping and maintaining monthly records

   e. Evaluation of records

2. Writing reports

a. Importance of reports

b. Major principles of report writing

c. Organization of the report

d. Mechanics of report writing

e. Effective writing

f. Types of reports

    (1) Monthly reports
    (2) Annual reports

3. Typical monthly report sample

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

Assist an operator in completing operation records for a month and in preparing the monthly report.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

The student must be able to complete records and write monthly reports which are complete, accurate, and communicate how the operation of the wastewater treatment plant is doing.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

A wastewater treatment plant is needed for the collection of records over a period of time to provide students with experience in collecting records to be used in writing a monthly report.

F. EXAMPLES OF SUPPORTING REFERENCES

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, pp. 17-1 - 17-25.

Emphasis is given not only to record keeping but also to the writing of the report which is the main means of information communication with the management and the general public.

2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. Pp. 149-155.

   An explanation is provided mainly on the keeping of records. Very little is said about the writing of the report.

IV

AIR POLLUTION CONTROL

The Effects of Particulates and Gases

The Effects of Topography and Weather on Air Pollution

Ambient Particulate and Gaseous Sampling Methods

Site Selection and Installation of Equipment

Recording Data and Analyzing Samples for Particulate and Gaseous Samplers

Combustion Evaluation

Odor Evaluation

Measuring Electronic Product Radiation

Noise Assessment

Complaint Investigation and Testifying in Court

Air Quality Reports

THE EFFECTS OF PARTICULATES AND GASES

UNIT CONCEPT: An adequate understanding of air pollution first demands a study of the harmful effects of particulates and specific gases on man, plant life, and materials. By studying the potential effects of harmful pollutants and standards of acceptable tolerance, the need for maintaining safe concentration levels of air-borne pollutants can be recognized.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. As determined by recognized authorities in the fields of medicine, plant sciences, and industry, explain the potential effects of specific gases and particulates on human health, plant life, and the durability of materials.

2. Upon reviewing the adverse effects of specific pollutants, identify which pollutants (at equivalent levels and at equivalent exposure periods) are most harmful to human health, plant health, and the wear life of materials, as determined by recognized authorities in the fields of medicine, plant sciences, and industry.

3. As set by the federal level of the Environmental Protection Agency, identify those federal standards which divide the maximum safe concentration levels from unsafe concentration levels of specific air pollutants.

B. INSTRUCTIONAL AREAS

1. The general adverse effects of manmade particulate material

    a. Some of the effects of soot, smoke, and dusts on the human body, particularly on the human respiratory system

        (1) The nuisance effects of particulates such as minor irritations of the eyes, throat, etc.

        (2) The potential effects of particulates such as asbestos fibers and metal dusts over long-term exposure
        (3) Adverse effects on persons with health conditions resulting from emphysema, allergies, etc.

    b. The general effects of industrial dusts and smoke on plant growth

        (1) Blockage of sunlight
        (2) Toxic effects of particulate deposits

    c. The most common effects of particulates on building materials and textiles

        (1) Soiling effects
        (2) Corroding effects caused by acid mists such as carbon and sulfur trioxide

2. Identifying the general adverse effects of manmade gaseous pollutants

    a. Some of the most common effects of sulfur dioxide, carbon monoxide, nitrogen oxides, hydrocarbons, and ozone on the human body, particularly on the respiratory and circulatory systems

        (1) The nuisance effects of gases such as loss of appetite, eye irritation, coughing, throat irritations, and odor
        (2) The potential effects of gases, such as constrictions of the chest, heart burden, etc., after continuous exposure to the pollutant
        (3) Adverse effects on persons with health conditions resulting from pulmonary diseases, lung cancer, bacterial infections

    b. Some of the representative symptoms of plant exposure to specific gases

        (1) Growth reduction
        (2) Leaf destruction
        (3) Chlorosis

    c. Those gases most destructive to building materials, textiles, and other materials

(1) Dissolving and fading of textiles
(2) Cracking of automobile tires caused by ozone
(3) Corroding of metals, painted surfaces, and masonry

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Should the environment be subject to average or heavy air pollution, the students will collect from the local area (and bring to class) any examples of possible pollutant damage to vegetation or materials. (The student may wish to take photographs and/or collect physical specimens.)

2. Using an environmental or ecological chamber, the students will expose plants or surface materials (such as fabric, rubber, and paint) to a laboratory-created polluted atmosphere. (Usually, a complete detailed experiment manual is included with the chamber.) Check for:

   a. The part of each plant which was affected by each pollutant

   b. Damage in relation to different concentrations and exposure time to plants, materials

   c. Any evidence of plant death or growth reduction

   d. Any symptoms which seem to relate to specific pollutants

3. Visit the nearest air pollution department or have an official visit the classroom to discuss the effects of the last air pollution episode. The highest concentration levels and the effects which were recorded at that time should be discussed.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Using a multiple choice format, have students select those effects most commonly associated with particulates and specific gases.

2. Each student will keep a log for recording his observations of pollutant effects within the environmental chamber. The teacher will evaluate each log or journal according to the accuracy of the student's observations.

3. A fill-in quiz will be given to check the student's competent knowledge of federal standards for safe concentrations of atmospheric pollutant content.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Movie projector and screen for presenting films on the effects of pollutants

2. Slides, slide projector and screen for presenting slide show on pollutant effects

3. Clippings from newspapers, magazines, and other publications on pollutant effects to incite class discussion

4. An environmental chamber for conducting controlled experiments on pollutant effects

F. EXAMPLES OF SUPPORTING REFERENCES

1. Air Pollution. Volume I. New York, New York: Academic Press. 1968.

   Part of a three-volume series, this text covers three main areas: tha nature of air pollution; the mechanism of its dispersal by meterological factors and from stacks; and its effects upon plants, animals, humans, materials, and visibility.

2. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

   This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

3. Air Pollution Primer. New York, New York: National Air Conservation Commission, National Tuberculosis and Respiratory Disease Association. 1969, 104 pages.

   This publication provides background information on air pollutants and their effects upon human health, plant life, and materials.

4. Introduction to Air Pollution Control. Washington, D.C.: The Office of Manpower Control, The Institute of Air Pollution Training. 1969.

A course manual, this publication emphasizes sampling and analysis procedures, the effects of pollutants, meteorology. and some information on air pollution control.

THE EFFECTS OF TOPOGRAPHY AND WEATHER ON AIR POLLUTION

UNIT CONCEPT: By studying the effects of local weather conditions and local topography, the student can predict periods of atmospheric stagnation or high pollution potential. An understanding of these factors can help the student interpret data collected from meteorological monitors he will attend, such as wind, temperature, and humidity instruments.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given a particular topographical environment, identify specific weather factors conducive to high air pollution potential, according to information from the field of air pollution meteorology.

2. According to information from the field of air pollution meteorology, identify the effects of specific topographical types on the transportation and diffusion of pollutants in a local area.

3. Given the manufacturer's instruction manual, operate the following instruments as a single unit to obtain an accurage record of wind behavior on the dual-channel strip-chart recorder.

    a. Wind vane

    b. Wind anemometer

    c. Dual-channel strip-chart recorder

4. Given specific weather factors conducive to high air pollution potential, predict the break-up or occurrence of air inversion, according to a local weather forecast and data from wind sensors.

5. Given the special inner-urban climate and wind patterns, explain the "heat island" effect and the "haze dome," applying information from class lectures and visual demonstrations.

B. INSTRUCTIONAL AREAS

1. Determining the effects of geographical location on broad-scale climate patterns that dominate an area

   a. The Great Lakes - Northeast area

      (1) Climate/land surface
      (2) High pollution potential

   b. The Gulf-Atlantic coastal area

      (1) Climate/land surface
      (2) High pollution potential

   c. The Appalachian area

      (1) Climate/land surface
      (2) High pollution potential

   d. The Great Plains area

      (1) Climate/land surface
      (2) High pollution potential

   e. Rocky Mountain area

      (1) Climate/land surface
      (2) High pollution potential

   f. West coastal area

      (1) Climate/land surface
      (2) High pollution potential

2. Determining the effects of local topographical types on the transportation and diffusion of air-borne pollutants

   a. The effects of the valley environment

      (1) Determining how inversions occur in the valley
      (2) Determining how winds move along the valley floor
      (3) Representative cities and relief maps

b. The effects of the shoreline environment

  (1) Determining how inversions occur along a shoreline
  (2) Defining and illustrating how a "circulation cell" contributes to an inversion condition
  (3) Representative cities and relief maps

c. The effects of the mountain environment

  (1) Determining how diffusion, or natural ventilation, is retarded by the box-like mountain environment
  (2) Determining how pollution sources on the leeward and windward sides of mountains (and hills) are affected by winds during stable and unstable conditions
  (3) Representative cities and relief maps

d. The effects of the inland plain environment

  (1) Determining why transportation and diffusion is usually good in the inland plains environment
  (2) Representative cities and relief maps

e. The inner-urban environment

  (1) Explaining the wind patterns and special climate caused by the unique inner-urban environment
  (2) Explaining the "heat island" effect and how it results in a "haze dome"
  (3) Illustrating wind patterns from the center of the city to the suburbs and back

3. Other factors which influence the speed and direction of the wind

a. The effects of the time of day

  (1) How morning winds contribute to an inversion
  (2) Afternoon winds

b. The effects of the seasons of the year on wind behavior

  (1) Autumn and winter
  (2) Spring
  (3) Summer

c. The effects of local obstructions on wind speed and direction

  (1) Terrain
  (2) Vegetation
  (3) Smoke stacks

4. The effects of local weather and climate on the high air pollution potential of an area

  a. Determining how the change of temperature with height above ground affects high air pollution potential

    (1) Effect on vertical air movement
    (2) Indications of high temperatures at high elevations
    (3) Indications of lower temperatures at high elevations

  b. Explaining how atmospheric pressure systems indicate how well pollutants will be diffused

    (1) The effects of low pressure systems
    (2) The effects of high pressure systems

  c. Explaining how high relative humidity contributes to high air pollution potential

    (1) How relative humidity depends on temperature, topography and wind inversion
    (2) How relative humidity absorbs particulates and gases in the atmosphere

  d. Explaining the negative effects of sunshine on a polluted atmosphere

    (1) The effects of photochemical smog
    (2) Typical smog environments

  e. Explaining the effects of precipitation on a polluted atmosphere

    (1) Precipitation as a natural cleansing device
    (2) Precipitation as a carrier of radioactive particles

  f. Explaining the effects of fog on a polluted environment

    (1) How fog contributes to an inversion condition
    (2) Environments favoring fog conditions

5. Recording wind speed and wind direction with the wind anemometer, wind vane, and the dual-channel strip-chart recorder

    a. The purpose of recording wind factors in the study of air pollution

    b. Identifying the component parts of the wind vane, anemometer, and recorder

    c. Operating the wind vane and anemometer with the recorder

        (1) Installing recording paper
        (2) Setting controls for a 30-day wind factor record

    d. Analyzing atmospheric stability from bi-hourly strip-chart headings

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Have students study the present season, temperature, pressure system, relative humidity, precipitation, and wind behavior in any geographical location. Ask them to decide if a high pollution potential alert could occur if these conditions remained the same for two or three days. Students should discuss their prediction for their specific location in class. Students should be specific.

2. Assign groups of four students to develop relief models of different local topography types. Each group will design its model from a relief map of a specific local topography, using quick-drying material such as plaster of paris. When models are completed, the groups will present their models and discuss the behavior of the winds and inversion potential of the local environment.

3. a. Have a student demonstrate before the class the operation of the wind vane, the wind anemometer, and the dual-channel strip-chart recorder.

    b. Twenty-four hour recordings of wind speeds and directions will be distributed throughout the class. Students must determine from bi-hourly observations whether the charts indicate stable or unstable conditions.

4. Different inversion conditions will be discussed in class in relation to specific weather factors that occurred during the inversion. Students will discuss the implications of these factors on the suspension or break-up of the inversion.

5. Two students will be asked to demonstrate before the class the "heat island" and the "haze dome" effects, using homemade models and visual aids.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Students will be given a true-false examination to determine their working knowledge of the probable effects of the following factors on high air pollution potential.

    a. Topography

    b. Temperature

    c. Atmospheric pressure

    d. Relative humidity

    e. Sunshine

    f. Precipitation

    g. Fog

2. Students will explain in a short essay or short answers: how inversions are created in the shoreline environment and the valley/mountain environment.

3. Under the supervision of the instructor, each student must demonstrate his competency in operating the wind sensor unit (vane, anemometer, and recorder). They should each be able to determine periods of stability and high instability on a 24- or 32-hour strip-chart.

4. Students must determine if inversions will break-up or continue, given specific examples of weather conditions which have been forecast for a specific topographical area.

5. Using a blank diagram, students must trace the wind patterns of the inner-urban environment and briefly discuss the "heat island" and "haze dome" effect.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Topographical relief maps of specific geographical locations and local topography types, slides or other visual aids to illustrate topography types and the effects of weather conditions; slide projector

2. Mixing buckets, plaster of paris, wire mesh for forming land contours

3. Wind vane, wind anemometer, dual-channel strip-chart recorder, rolls of strip-chart paper, samples of strip-chart data for class distribution

F. EXAMPLES OF SUPPORTING REFERENCES

1. Air Pollution. Volume I. New York, New York: Academic Press. 1968.

   Part of a three-volume series, this text covers three major areas: the nature of air pollution, the mechanism of its dispersal by meteorological factors and from stacks, and its effects upon plants, animals, humans, materials and visibility.

2. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

   This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed instructions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

3. Weather Instruments. Dallas, Texas: Texas Electronics, Inc. 12 pages.

   An instructional manual, this manufacturer's publication contains guidelines for installing, operating, and maintaining weather instruments measuring wind behavior, humidity, temperature, and precipitation.

AMBIENT PARTICULATE AND GASEOUS SAMPLING METHODS

UNIT CONCEPT: Every local air pollution control agency must have continuous access to data on specific gases and particulates which indicate the quality of community air. By properly assembling, operating, and maintaining air monitoring samplers, accurate and representative samples of the local air can be collected.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given the manufacturer's manual of operating instructions, properly operate the following equipment to obtain accurate and representative samples of the local air.

   a. High volume sampler

   b. Cascade impactor

   c. Dustfall collector

   d. Adhesive impactor

   e. Tape spot sampler

   f. 5-Gas sampler

   g. Lead peroxide candle

2. Given the manufacturer's manual of operating instructions, perform the maintenance for each instrument he operates, so that accurate and representative samples are obtained.

3. Given the manufacturer's manual of operating instructions, correctly use accessory equipment for the operation of specific samplers, during weighing procedures, during drying procedures, and for the general handling of samples.

B. INSTRUCTIONAL AREAS

1. Sampling air borne particulates

    a. High volume filter sampler

        (1) Identifying the filter, filter holder, filter support screen, vacuum pump, rotameter, flow chart, shelter design, timer
        (2) Determining how air is drawn into the sampler, how particulates are collected, and how flow rate is recorded
        (3) Setting up and operating the high volume sampler

            (a) Drying and weighing the filter before and after sampling period
            (b) Installing the filter
            (c) Installing the circular flow chart
            (d) Recording the rate of air flow through the filter
            (e) Setting the automatic timer
            (f) Exposure time

    b. Cascade impactor

        (1) Identifying collection plates, aluminum collection disks, back-up filter, shelter design, and pressure gauge
        (2) Determining how air is drawn into the sampler, how particulates are fractionated, and how flow rate is recorded
        (3) Setting up and operating the cascade impactor

            (a) Drying and weighing the back-up filter and collection disks before and after sampling period
            (b) Disassembling collection plates
            (c) Installing filter
            (d) Installing aluminum collection disks
            (e) Setting automatic timer
            (f) Recording the rate of air flow through the impactor
            (g) Exposure time

    c. Dustfall collector

        (1) Identifying collection medium, container design and container support

(2) Determining how sampler collects particulates and how dustfall samples can be altered by natural forces of winds, rainfall, and snowfall

(3) Setting up the high volume sampler

(a) Preparation of collection medium
(b) Mounting sampler
(c) Exposure time

d. Adhesive impactor

(1) Identifying container design, container support, adhesive paper
(2) Determining how sampler collects particulates
(3) Setting up the adhesive impactor

(a) Replacing sticky tape
(b) Compass marks
(c) Exposure time

e. Particulate tape spot sampler

(1) Identifying inlet tube, sampling nozzle, filter tapes and reels, densitometer (some models), vacuum pump, flow meter
(2) Determining how air is drawn into sampler, how particulates are deposited on filter tape on pre-determined intervals, how filter tape is moved through sampler
(3) Setting up and operating the particulate tape spot sampler

(a) Instrument check-up
(b) Preparing and loading tape reels
(c) Setting timer for moving tape at measured intervals
(d) Setting flow rate
(e) Checking flow rate
(f) Exposure time

2. Sampling gaseous pollutants

a. Lead peroxide candle

(1) Identifying gauze-covered cylinder, lead peroxide powder-paste, transporting tubes, control candle shelter design, sampler support

(2) Determining how sulfur dioxide enters shelter and how it is collected
(3) Setting up the lead peroxide candle

  (a) Preparing candle
  (b) Preparing lead peroxide paste
  (c) Drying candle before sampling
  (d) Preparing control candle
  (e) Transporting candle to site
  (f) Mounting candle
  (g) Exposure time

b. Fluoride tape spot sampler

(1) Identifying all component parts listed for the particulate tape spot sampler; identifying extra tape system, identifying fluoride tape
(2) Determining operations as listed for the particulate tape spot sampler
(3) Setting up and operating as for the particulate sampler In addition:

  (a) Installing gaseous fluoride tape on lower reel
  (b) Installing particulate fluoride tape on upper reel

c. 5-Gas sampler

(1) Identifying inlet funnel, vacuum pump, membrane inlet filter, "demistor" tubes, glass inlet manifold, regulating orifices, exhaust, timer
(2) Determining how gases are drawn into sampler, how different gases are sampled, and how flow rate is recorded
(3) Setting up and operating the 5-Gas sampler

  (a) Set up funnel and tubing
  (b) Prepare reagent
  (c) Fill demistor trap
  (d) Set up pump
  (e) Set timer switch
  (f) Assemble calibration unit to check flow rate
  (g) Exposure time

3. Maintaining gaseous and particulate samplers

    a. High volume sampler

        (1) Lubricate hinges
        (2) Clean shelter
        (3) Clean recording chart apparatus and pen
        (4) Clean motor housing
        (5) Clean rotameter

    b. Cascade impactor - There is essentially no maintenance required of this instrument.

    c. Dustfall collector - There is essentially no maintenance required of this instrument.

    d. Adhesive impactor - There is essentially no maintenance required of this instrument.

    e. Tape spot sampler

        (1) Replace filter jars and filter jets
        (2) Lubricate take-up spool motor
        (3) Replace fuses
        (4) Lubricate rear end motor bearing
        (5) Replace densitometer bulb
        (6) Clean nozzle windows
        (7) Replacement of parts (consult manufacturer)

    f. Lead peroxide candle - There is essentially no maintenance required of this instrument.

    g. 5-Gas sampler

        (1) Replace air filters
        (2) Clean matched orifices with manufacturer's cleaner
        (3) Clean shelter (if present)

4. Use accessory equipment during sampling procedures for specific samplers

    a. Desiccator

        (1) Set standard temperature
        (2) Set standard moisture content (humidity)

b. Analytical balance

  (1) Set null indicator
  (2) Set control knobs to zero
  (3) Adjust for digital reading
  (4) Maintenance

c. Rotameter - read to nearest whole number (cubic feet per minute)

d. Continuous flow chart

  (1) Average every 15-minute interval to nearest whole number
  (2) Record in cubic feet per minute

e. Timers

  (1) Set trippers
  (2) Set time

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Having demonstrated before the class the operations of each sampler, have groups of three or four students follow the manual of instruction for operating their assigned sampler. The teacher should monitor the class and answer student questions. When each group member can operate his assigned sampler without error, the group will rotate to another sampler. (If a member is particularly slow, his group should not be retained.)

2. a. Using the manufacturer's manual of operating instructions, have students disassemble the component parts of each sampler for proper maintenance procedures, such as lubrication, cleaning, and replacing parts. (Use the same group-rotation procedures as in C.1. above.)

   b. Using instruments which are not operating properly and are taking inaccurate samples, assign groups of two or three students to the instrument and ask the group to "diagnose" the problem and suggest the necessary maintenance.

3. Have the students demonstrate before the class the proper use of such accessory instruments as the desiccator, forceps, the analytical balance, the rotameter, chemical reagents, recording charts, and timers.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Using mimeographed, exploded-view diagrams of the component parts of each sampler, have the students label these parts and identify the sampler by its function or purpose.

2. Have each student draw (at random) the name of a sampler. Without preparation and under supervision, he must set up and operate that sampler in a simulated field assignment.

3. Have each student determine the tare weight, the gross weight, and the particulate weight (in grams) of a high volume filter, using the analytical balance.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Movie projector and screen for presenting films demonstrating the operation of particulate and gaseous samplers

2. Slides, carousel, filmstrips, screen, etc., to identify the component parts of the samplers

3. High volume sampler, cascade impactor, dustfall collector, adhesive impactor, tape spot sampler, 5-Gas sampler, lead peroxide candle

4. Fiberglass or cellulose filters, circular recording charts, impactor back-up filters, aluminum collection disks, forceps, 20-mesh sieve, pyrex beaker, adhesive paper, protective spray lacquer, particulate and fluoride filter tapes, lead peroxide paste, prepared reagents, 5-Gas orifice needles, distilled water, glass wool

5. Analytical balance, desiccator, rotameter, calibration unit, timers

F. EXAMPLES OF SUPPORTING REFERENCES

1. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

   This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

2. A.I.S.I. Automatic Samplers, Operating Instructions. Allison Park, Pennsylvania: Research Appliance Company.

   An operations manual, this publication includes complete instructions for operating the tape spot sampler and analyzing sample spot optical densities on the filter tape.

3. Educational Air Pollution Study Kit. Allison Park, Pennsylvania: Research Appliance Company.

   An operations manual, this publication includes complete instructions for preparing and analyzing samples from the dustfall collector and adhesive impactor.

4. 5-Gas Collecting Sampler, Operating Instructions. Allison Park, Pennsylvania: Research Appliance Company. 21 pages.

   An operations manual, this publication includes complete instructions for operating the 5-Gas sampler, preparing specific reagents, and calculating results.

5. Gruber, Charles W. A Summary of Recommended Standard Methods for Measuring Wind-Blown Nuisance Particulates. Allison Park, Pennsylvania: Research Appliance Company.

   An operations manual, this publication includes instructions for operating the Gruber comparator and analyzing results.

6. Standard Methods of the Measurement of Ambient Air Quality. Columbus, Ohio: Ohio Environmental Protection Agency. 1973, 84 pages.

   An instructions manual, this publication includes instructions for operating and analyzing samples from the high volume sampler, 5-Gas sampler, and the tape spot sampler.

SITE SELECTION AND INSTALLATION OF EQUIPMENT

UNIT CONCEPT: The correct siting and installation of pollutant samplers and wind instruments is essential if accurate and representative samples and wind data are to be collected.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given standard guidelines published by the Environmental Protection Agency on air quality surveillance networks, select a site for the installation of gaseous and particulate samplers, according to location of nearby obstructions.

2. Given standard guidelines published in the field of air pollution meteorology, select a site for the installation of wind instruments, according to:

    a. The location on or near a building

    b. The location in a rural area

3. As recommended by personnel in the field of air pollution inspection, install air pollutant and wind monitors, according to the following criteria:

    a. Providing a stable base for securing sampling equipment

    b. Providing electrical power

    c. Protecting the sampling station from vandalism

B. INSTRUCTIONAL AREAS

1. Types of surveys for monitoring air contaminants and wind characteristics

    a. The general community air survey

        (1) Purpose of the survey
        (2) Standard location of the instruments

    b. The specific source monitoring survey

        (1) Purpose of the survey
        (2) Standard locations of the instruments

2. Selecting a site for gaseous and particulate samplers

    a. Placing instruments at specific minimum distances from obstructions so that representative samples can be obtained

        (1) Distance from higher buildings
        (2) Distance downwind from trees, in a rural zone
        (3) Distance upwind from chimneys on the sampling station roof
        (4) Distance upwind from any nearby operating stacks

3. Selecting a site for wind instruments to detect prevailing wind speed and direction

    a. Placing wind instruments on or near a city building

        (1) Locating instruments on the ground level
        (2) Locating instruments on a sampling station rooftop

    b. Placing wind instruments in a rural zone at a specific distance from local obstructions

4. Installing air sampling equipment at the sampling site

    a. Constructing a stable base for securing the equipment to ground or rooftop

        (1) Construction materials
        (2) Directions for construction

    b. Providing electrical power at the sampling site

        (1) Grounding all portable equipment
        (2) General safety precautions

c. Protecting the instruments at the sampling station from vandalism

(1) Protecting the sampling station located on the ground level
(2) Protecting the sampling station located on a rooftop

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. a. Students will practice setting up high volume samplers in locations where local obstructions exist.

   b. Place two samplers near one of the following local obstructions: buildings, trees, rooftop chimney, smoke stack. Place one sampler following standard meteorological guidelines; site the other sampler in close proximity to the obstructions. Samples will be collected from each instrument and compared in class.

2. Students will select exact sites for wind sensors in the urban location.

3. Students will construct bases for securing sampler stanchions and shelters.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Students will submit high volume samples from specific monitoring instruments they have sited near local obstructions. Samples will be acceptable if they are representative of the local air, without undue influence from any specific type of obstruction.

2. A student must verbally justify his selection of a wind sensor site according to the distance from any local obstructions and why he has chosen a site upwind or downwind from those obstructions.

3. All students must be able to properly install any air pollution sampler at the source by constructing a stable base for a sampler.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Wind vane, wind anemometer, dual-channel strip-chart recorder

2. 100-foot tape measure (measuring some distances)

3. Slats, nails, bolts, concrete blocks

F. EXAMPLES OF SUPPORTING REFERENCES

1. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

   This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed instructions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

2. Guidelines: Air Quality Surveillance Networks. No. AP-98. Research Triangle Park, North Carolina: Office of Air Programs, Environmental Protection Agency. 1971, 16 pages.

   This government publication is designed to assist state and local agencies set up air quality surveillance programs. It includes guidelines for selecting a particular site based upon the representativeness of the area and other practical aspects such as housing the samplers, electric power, and security from vandalism.

RECORDING DATA AND ANALYZING SAMPLES FOR PARTICULATE AND GASEOUS SAMPLERS

UNIT CONCEPT: The air pollution inspector must record certain basic information during routine sampling procedures. This data and a primary analysis conducted by the inspector, provides a base for further analysis by skilled technicians, engineers, and chemists.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Using the standard form from any local air pollution department, record specific information for each piece of monitoring equipment, before and after the sample is taken.
    a. Dustfall collector
    b. High volume sampler
    c. Tape spot sampler (gas and particulate)
    d. 5-Gas sampler
    e. Lead peroxide candle
    f. Cascade impactor
    g. Adhesive impactor
2. Given the network's own filters, sampling tubes, reagents, and sampling schedules, record specific bi-monthly data for the 5-Gas sampler and the high volume sampler before and after the sample is taken, to satisfy the requirements of the Standard National Air Surveillance Network (N.A.S.N.) form.
3. Given the manufacturer's manual of operating instructions, operate the following instruments to be used in the analysis of samples after the samples are taken to the laboratory.

  - a. Gruber comparator
  - b. Tape spot evaluator
  - c. Muffle-type laboratory furnace

4. Given a 30-day dustfall sample, determine the total tons of dustfall per square mile for that sampling period.

5. Given a 7-day sample from an adhesive impactor, determine the particles per square inch for each of eight compass directions.

6. Given samples of particulate deposits on filter tape, convert the percentage of light density (read from a tape spot evaluator) into coefficient of haze for each particulate deposit.

B. INSTRUCTIONAL AREAS

1. Recording information at the sampling site for each sampler in use

  a. Basic information to be recorded for all samples

    (1) Operator's (student's) name
    (2) Sampling site
    (3) Time and date sampling period began
    (4) Time and date sampling period ended

  b. Additional information for the high volume sampler

    (1) Flow rate at beginning of sampling period (cubic feet per minute - CFM)
    (2) Flow rate at end of sampling period (CFM)
    (3) Mean flow rate (CFM)
    (4) Tare weight of filter (pre-sample weight)
    (5) Gross weight of filter (soiled filter weight)
    (6) Particulate weight (in grams)
    (7) Filter number
    (8) Total time in minutes

  c. Additional information for the dustfall collector - opening size of collector

d. Additional information for the tape spot sampler

  (1) Sampling time intervals
  (2) Initial setting of flow rate (cubic feet per hour - CFH)

e. Additional information for the 5-Gas sampler

  (1) Initial setting of flowrate (milliliter per minute - ml./m.)
  (2) Sampling time intervals

f. Additional information for the adhesive impactor

  (1) Prevailing wind direction indicated on impactor tape
  (2) Sampling time intervals

2. Recording information at the sampling site for the National Air Surveillance Network

  a. Sampler serial number

  b. Site (city)

  c. Sampler location

  d. Filter number

  e. Wind direction and force

  f. Visibility

  g. Sky condition

  h. Humidity

  i. Temperature

  j. Date

  k. Hours sampled

  l. Flow rate (beginning, end)

  m. Additional comments

3. Procedures for analyzing samples from the dustfall collector, the adhesive impactor, and the tape spot sampler

    a. Dustfall collector

        (1) Determining the weight of soluble and insoluble particulate material
        (2) Using pre-collected data, convert grams per square meter per month into tons of dustfall per square mile per month

    b. Adhesive impactor

        (1) Determining particles per square inch (in eight compass directions) using the Gruber comparator
        (2) Determining particles per square inch without a Gruber comparator

    c. Tape spot sampler

        (1) Determining what percent of light is passing through each particulate deposit on the tape by reading a tape spot evaluator or a densitometer built into the sampler
        (2) Converting the percent of light transmission into the coefficient of haze (COH) units per 1,000 feet using:

            (a) Air sample volume (flow rate)
            (b) Percent of light transmission
            (c) Conversion chart

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Each student is assigned to a particular sampler to record information before and after the sample is collected. (Students should record data for all instruments.)

2. Each student will go to the sampling site and record instrument, meteorological, and general data using appropriate N.A.S.N. forms. Later they can break up into groups of four to compare results, then compare results between groups to determine the most accurate data.

3. Given a particulate sample from an adhesive impactor, students will determine particles per square inch in eight different locations on an adhesive impactor sample, without using the Gruber comparator.

4. Divide the students into teams of four and let the teams compete in calculating the following, using efficiency and accuracy as basic criteria.

   a. COH units per 1,000 feet (tape spot evaluator)

   b. Particles per square inch (Gruber comparator)

   c. Tons of dustfall per square inch (dustfall collector, muffle furnace, laboratory equipment)

5. Two students (volunteer or teacher selected) will demonstrate the preparation and weighing procedures for determining the total weight of dustfall

6. Assuming that a state standard exists, a student will be given the responsibility of contacting the state or regional Environmental Protection Agency for the smoke concentrations (COH units: light, moderate, heavy, very heavy, extremely heavy). He will report his findings to the rest of the class and give possible reasons why these particular limits were set for his state.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Each student must keep a record of data for each sampler. This data will be turned in and evaluated for accuracy and efficiency.

2. All students will record data on N.A.S.N. forms for the high volume sampler and 5-Gas sampler. This data will be evaluated according to the accuracy of flow rates, time, and meteorological conditions. It will also be evaluated according to the keen observations of any unusual conditions at the site.

3. Each student will be assigned samples from either the dustfall collector, the tape spot sampler, or the adhesive impactor. Under close supervision, the student will conduct a complete analysis of his sample, including any necessary calculations or conversions.

4. Students will be given a 30-day dustfall sample and will determine the total tons of dustfall per square mile, without error.

5. Students will be given a 7-day sample from an adhesive impactor and will determine the particles per square inch for each of eight compass directions, without error.

6. Students will be given samples of particulate deposits on filter tape and will convert the percentage of light density into coefficient of haze for each particulate deposit, without error.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Set up and ready to operate: dustfall collector, high volume sampler, tape spot sampler, 5-Gas sampler, lead peroxide candle, cascade impactor, adhesive impactor

2. Standard forms for recording data from routine sampling procedures

3. Standard National Air Surveillance Network forms from the nearest N.A.S.N. office

4. Gruber comparator, tape spot evaluator, densitometer, muffle-type furnace, analytical balance, desiccator

5. Sieve, 1,000 milliliter beakers, evaporating dish, medium size filtering crucible, thermo-regulated hot plate, illuminated magnifier (14X magnification), scissors, COH conversion chart

F. EXAMPLES OF SUPPORTING REFERENCES

1. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

   This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

2. A.I.S.I. Automatic Samplers, Operating Instructions. Allison Park, Pennsylvania: Research Appliance Company.

   An operations manual, this publication includes complete instructions for operating the tape spot sampler and analyzing sample spot optical densities on the filter tape.

3. Collection and Analysis of Dustfall: Instructions. Allison Park, Pennsylvania: Research Appliance Company.

   An operations manual, this publication describes methods of using the dustfall collector and analyzing particulates settling out of the ambient air.

4. Educational Air Pollution Study Kit. Allison Park, Pennsylvania: Research Appliance Company.

   An operations manual, this publication includes complete instructions for preparing and analyzing samples from the dustfall collector and the adhesive impactor.

COMBUSTION EVALUATION

UNIT CONCEPT: Air pollution inspectors in many areas investigate sources of combustion operations. By inspecting boilers and furnaces, and by observing illegal emissions from smoke stacks, chimneys, and motor vehicle exhausts, the inspector may cause the reduction of inefficient combustion at the source, thus reducing pollution.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given a Ringlemann-type Smoke Chart, determine the density or opacity of smoke emitted from stationary and moving combustion sources at 15-second intervals, with an average deviation of no more than 1/2 a Ringlemann number of 20% opacity.

2. Given a series of Ringlemann readings taken at 15-second or 30-second intervals, record all readings on a smoking reading data form so that the percentage of smoke density or opacity can be calculated.

3. Given a completed smoke reading data form, calculate the average percentage of smoke density or opacity, according to the smoke calculation method designed by the U.S. Bureau of Mines.

4. Observing an automobile or a commercial truck emitting excessive exhaust smoke, report specific data while following the motor vehicle violator, conducting the investigation according to local standards.

5. Given a small furnace or boiler over 400,000 B.T.U. capacity and the manufacturer's manuals of operating instructions, operate the following instruments, without error.

   a. Draft gauge

   b. Thermometer

   c. Carbon monoxide indicator

   d. Carbon dioxide indicator

B. INSTRUCTIONAL AREAS

1. Evaluating the density of smoke plumes and smoke exhausts

    a. Acquiring the major supplies required for a complete evaluation of smoke coming from stationary sources

        (1) Polaroid camera
        (2) Smoke reading data form
        (3) Ringlemann-type Smoke Chart
        (4) Automatic particulate tape spot sampler

    b. Evaluating stationary combustion sources, using the Ringlemann-type Smoke Chart to evaluate smoke emissions

        (1) The standing position when evaluating smoke during the daylight hours and the nighttime hours
        (2) The distance to stand from the combustion source when reading a plume
        (3) The angle to stand from the smoke plume
        (4) The proper way to hold the smoke chart during a reading
        (5) The proper method for reading the chart for white smoke and for black smoke
        (6) Observation time
        (7) Reporting specific data on the smoke reading form
        (8) Determining the average percentage of smoke density or opacity during an evaluation period of one hour

    c. Using the tape spot sampler if in doubt of the Ringlemann test

        (1) Siting around source in question
        (2) Setting the sampler for the appropriate sampling intervals

    d. Evaluating smoke emitted from motor vehicle exhausts without direct use of the Ringlemann Smoke Chart

        (1) Following vehicle along street
        (2) "Reading" exhaust density
        (3) Standard procedures for checking a violator of an automobile
        (4) Standard procedures for checking a violator of a commercial truck

2. Inspecting a boiler or furnace in a small establishment for efficiency of combustion procedures

a. Recording general information concerning the instrument in question

b. Recording additional data before equipment is inspected

c. Locating a sampler opening in the exhaust end of the furnace

d. Taking the temperature of the flue gas within the furnace or boiler exhaust duct

e. Measuring the air current ("draft") within the furnace or boiler exhaust duct

f. Measuring the concentration of carbon monoxide in exhaust gases using a carbon monoxide indicator

   (1) Using the basic CO indicator and color chart, for analysis
   (2) Using the carbon monoxide indicator sampler without color matching, for analysis

g. Measuring the concentration of carbon dioxide in exhaust gases using the carbon dioxide analyzer

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. a. If a smoke generator is available, have students practice reading dark smoke plumes (Ringlemann number measurement) and white smoke plumes (percent equivalent opacity).

   b. Professional inspectors often do not use the Ringlemann-type Smoke Chart in the field and never use it for evaluating moving sources. Students should practice fixing the shades in their memories. Have students repeat exercises C.1.a. or C.2. without a smoke chart.

2. If a smoke generator is not available, use slides to go through a sample smoke exercise of five black and five white shades for a stationary source. Have students fill out a smoke reading form and make computations in class or at home in the evening.

3. When the students have taken smoke readings and recorded them on the smoke reading form, each is responsible for calculating percent of smoke density or opacity.

4. Using a movie or an actual moving car or truck, have students watch or follow a car or truck with heavy exhaust emissions to determine opacity or density of the smoke.

5. Locate, for practice runs, a furnace or boiler over 400,000 B.T.U. capacity. Have the students determine the CO and CO_2 concentrations, measure the draft, and determine the temperatures of the exhaust emissions using the following instruments, respectively.

   a. Carbon monoxide indicator

   b. Carbon dioxide indicator

   c. Draft gauge

   d. Thermometer

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. If a smoke generator is available, conduct outdoor smoke reading proficiency tests based on the following student requirements:

   a. Observe twenty-five black and twenty-five white shades

   b. White recorded in percent equivalent opacity, black recorded in Ringlemann numbers

   c. Deviations from correct measurements:

      (1) Black - none of one Ringlemann number or more
      (2) White - none of 20% or more

   d. Average deviation for all fifty readings is less than 7.5%

   e. Everything is accomplished on one series of runs

   f. Training form to be filled out and turned in

   g. Read at the sound of the horn

   h. Correct readings announced at completion

2. Students will calculate percent optical density or opacity from smoke readings without error.

3. Show to the class twenty-five slides of violating and non-violating motor vehicles. Students must rate each vehicle without error. Each student will, in written form, explain the proper violation procedures for a truck violator and an automobile violator.

4. Students will be taken in groups of four to the site of a furnace or boiler. Each student must accurately:

   a. Record all pre-sampling data on a sample combustion evaluation form

   b. Take the temperature of exhaust emissions using a thermometer

   c. Measure the draft within the exhaust duct using a portable draft gauge

   d. Measure the percentage of CO using one of the following:

      (1) Basic CO indicator and color chart
      (2) Carbon monoxide indicator sampler

   e. Measure the percentage of CO_2 using the fyrite analyzer

   f. Record all information on the combustion evaluation form

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Ringlemann-type Smoke Charts, U.S. Bureau of Mines smoke reading chart or a smoke training school chart, polaroid camera, automatic particulate tape spot sampler

2. Local regulations regarding the procedures for investigating violating motor vehicles

3. Data forms for the inspection of furnaces or boilers

4. Manuals or operating instructions, dial thermometer with sampling probe, cloth, draft gauge with sampling probe, basic CO indicator assembly, a standard color chart for the basic CO indicator, caps for indicator tubes, carbon monoxide indicator sampler with rubber tubing and connector tip, fyrite analyzer assembly

5. Slides, 35 mm (2" X 2") slide projector, overhead projector (vu-graph) for showing large transparent figures

F. EXAMPLES OF SUPPORTING REFERENCES

1. Air Pollution Control Field Operations Manual. Washington, D.C.: U.S. Department of Health, Education and Welfare, U.S. Government Printing Office. 1962, pp. 155-166.

   This publication was originally prepared as a training manual for field personnel of the Los Angeles district. This manual describes, in detail, the field inspection and enforcement activities required in any effective air pollution control program.

2. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

   This manual provided much of the source background for this Air Pollution Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

3. Evaluations of Visible Emissions. Parts I, II, and III. Columbus, Ohio: Battelle Laboratories. 1973, pp. B-95 - B-103, B-123 - B-142.

   This source includes two manuals. The Instructor's and Operator's manual is designed to train air pollution inspectors to measure the shade of visible emissions. It includes instructions for operating a smoke generator and lesson plans for the instructor. The student's manual is a course manual, which includes units in meteorology and testifying in court.

ODOR EVALUATION

UNIT CONCEPT: Odors can cause considerable discomfort to a substantial number of people in a community. Monitoring this air pollutant is important in detecting when objectionable levels are reached and in determining the source, so that remedial action can be taken.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given complaint information provided by the complainants, when a single source is in question, determine the specific odor source to the satisfaction of the instructor.
2. Given odor samples of different fragrance types (quality reference standards) and a standard odor quality scale, rate the quality of the odor to within one whole number.
3. Given odor samples of different strengths and the Psychophysical Intensity Scale, rate the intensity of the odor in question, without error.
4. Given a diagram map of potential odor sources and sites of repeated odor complaints, conduct an inspection of community odors to satisfy the requirements on an odor patrol report form.
5. For a section of the community from which a number of odor complaints have occurred and using a prepared questionnaire, conduct a community odor survey which obtains a general consensus of the community odor problem.

B. INSTRUCTIONAL AREAS

1. Field patrol of the community odor problem
    a. Determining the locale of the specific odor source
        (1) Determining the prevailing wind patterns at the time the nuisance odor occurs

    - (2) Information in layman's terminology from complaint investigation

  - b. Conducting a field patrol inspection of the community odor(s) in question
    - (1) Following a map designating potential odor sources and complaint sites
    - (2) Using the odor patrol report
    - (3) Determining odor quality
    - (4) Determining odor intensity
    - (5) Determining wind direction

2. Conducting the community odor survey

  - a. Selecting observers to be interviewed in the survey
    - (1) Random selection
    - (2) Representative group from the population troubled by the nuisance odor(s)
    - (3) Voluntary participation

  - b. Measuring odors
    - (1) Determining odor intensity using the Psychophysical Intensity Scale
    - (2) Determining odor quality using the quality reference standards from the Crocker-Henderson Scale, Hennings Odor Classification, and the Foster Odor Chart

  - c. Collecting data for the community survey questionnaire
    - (1) Date of survey
    - (2) Location of individual contacted
    - (3) Length of residence
    - (4) Description of odor quality
    - (5) Description of odor intensity
    - (6) History of any improvement
    - (7) Time of day when odor is most intense
    - (8) Weather effects
    - (9) Wind directions
    - (10) Any indications of illness

3. Evaluating the results of a community odor survey
    a. General summarization of results
    b. Determining what kinds of odor dominate the survey area
    c. Determining the percentage of all odors classified in specific categories on the odor intensity scale
    d. Associating odor sources with prevailing wind directions
    e. Determining when and where odors are most frequently noticed

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Take a field trip to the nearest air pollution control department which conducts odor studies. Ask the senior inspector or other personnel to discuss methods used by the department to inspect odors and track odor sources.

2. & 3. Using a gas and odor control experiment kit (or similar apparatus, such as an aspirator bulb, side-arm filter flask, rubber stopper with pipe, rubber tubing attached to aspirator bulb), inhale various gaseous odors placed in the flask by the instructor. Practice rating the quality and intensity of each odor, using respective scales.

4. Students should "patrol" their own community for any indications of odors, using an odor report form based on the criteria in B.1.b. Whenever an odor is noticed, the student should proceed to report appropriate data.

5. Create a community survey questionnaire, applying the criteria listed in B.2.c. Questions should be stated in such a way that any resident over the age of sixteen could typically answer them.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Students will be taken to a site of frequent odor complaints. The students will be asked to determine the odor source, presenting a rationale which is satisfactory to the instructor.

2. & 3. Each student will be asked to use the following scales with respective accuracy:
    a. Psychophysical Intensity Scale - off no more than one number
    b. Crocker-Henderson Scale - without error
    c. Henning's Odor Classification - without error
    d. Foster's Odor Chart - off no more than one whole number
4. Once each student has "patrolled" his community and selected odor sites, he must, under supervision, choose one site and record all data without error at the site.
5. All community survey questionnaires must be turned in for evaluation. Criteria will be checked. Questionnaires will be judged on their practicality and correct application of criteria.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Odor quality scales
    a. Henning's Odor Classification
    b. Crocker-Henderson Scale
    c. Foster's Odor Chart
2. Odor intensity scale - Psychophysical Intensity Scale
3. Odor patrol report forms, pencils, possible maps of local area indicating sources from which odors might be emitted
4. Aspirator bulbs and tubing, side-arm filter flasks, rubber stoppers and glass tubing

F. EXAMPLES OF SUPPORTING REFERENCES

1. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

2. Community Odor Surveys and Evaluation. Cincinnati, Ohio: Division of Air Pollution, Robert A. Taft Sanitary Engineering Center. 1965, 12 pages.

This publication discusses the conduct and application of odor surveys, essentially useful in providing background information on odor problems in a community.

MEASURING ELECTRONIC PRODUCT RADIATION

UNIT CONCEPT: Potentially harmful radiation can be emitted from such electronic products as microwave ovens, medical, dental, and industrial x-ray machines, and color television sets. By monitoring these radiation sources through an electronic product radiation control program after installation, emissions of and the exposure of people to unnecessary electronic product radiation can be detected, and thus, minimized.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given the manufacturer's manual of instructions, assemble and operate the following survey instruments without error:
    a. Ionization rate meter ("Cutie Pie")
    b. Condenser R-meter
2. Given an operating ionization rate meter or a condenser R-meter, read the radiation level on the dial meter to the nearest roentgen.
3. According to standards set by the U.S. Department of Health, Education and Welfare, identify the general procedure for surveying an electronic radiation product installation.

B. INSTRUCTIONAL AREAS

1. Introducing radiation as a potentially harmful "pollutant"
    a. Defining radiation by comparing radiation energy travel to the travel of light
    b. Discussing the principle adverse effects that radiation can have on human health
        (1) Injury to the skin

   - (2) Injury to blood-forming tissue
   - (3) Injury to genetic tissue
   - (4) Cancer

c. Discussing the specific sources of potentially harmful radiation relevant to the objectives of this unit

   - (1) Medical and dental x-ray machines used for patient treatment and diagnosis
   - (2) Industrial x-ray machines and their uses
   - (3) Microwave ovens

2. Assembling and operating radiation monitoring instruments

   a. Using the film badge to monitor personnel who may be receiving excessive radiation exposure

      - (1) Identifying the film badge holder and film packet
      - (2) Demonstrating how a film badge should be worn
      - (3) Discussing how film is analyzed by the company supplying the films

   b. Using the clip-on pocket chamber to monitor personnel exposed to radiation in the working environment

      - (1) Identifying the pocket chamber and the separate charger-reader
      - (2) Demonstrating how a pocket chamber should be worn
      - (3) Measuring the radiation dosage (received by a person over a specific time span) with the charger-reader in millirads.

   c. Using the clip-on pocket dosimeter to monitor personnel exposed to radiation in the working environment

      - (1) Identifying the pocket dosimeter and charger
      - (2) Demonstrating how a pocket dosimeter should be worn
      - (3) Measuring the radiation dosage (in millirads) by holding the dosimeter up to the light

   d. Using the ionization rate meter ("Cutie Pie") to measure the amount of radiation emitted from an operating radiation source

      - (1) Identifying the charger-reader, the R-chamber and plastic

    cap, dials on the charger-reader, and the ionization chamber holder
    - (2) Assembling the charger-reader and R-chamber to measure radiation in roentgens
    - (3) Charging the chamber and adjusting the instrument to "zero"
    - (4) Reading the chamber in milli-roentgens
    - (5) Calculating the true roentgen output per second

  - e. Using the condenser R-meter to measure the amount of radiation emitted from an operating radiation source ("scatter radiation")

    - (1) Identifying the R-meter and meter scale, adjustable dial settings
    - (2) Reading the meter scale in milli-roentgens per hour
    - (3) Multiplying by the scale setting to obtain a correct reading when setting is not on "x 1" (times one)

3. Conducting a general radiation protection survey at electronic radiation product installations

  - a. Discussing the general purpose of the survey

    - (1) Monitoring specific equipment used in an operation
    - (2) Monitoring radiation exposure of individual personnel

  - b. Preparing for the survey

    - (1) Making advance arrangements before the actual visit
    - (2) Making introductions to the responsible person(s)
    - (3) Setting up monitoring equipment

  - c. Interviewing the equipment operator, doctor, or dentist for information not included in the physical survey

    - (1) General information (address, city, county, etc.)
    - (2) Personnel information
    - (3) Information concerning the specific type of radiation source under inspection

  - d. Surveying the electronic product (physical inspection)

    - (1) Identifying the product

(2) Measuring the roentgen output with an ionization rate meter, or "Cutie Pie"
(3) Measuring the scatter radiation with a condenser R-meter
(4) Checking for protective measures taken by the personnel and the operator of the product
(5) Examining safety features specific to each product

e. Concluding the survey

(1) Consulting with the operator or his assistant with the aid of the senior inspector
(2) Checking that all pertinent information has been included on the specific data form

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. a. Have groups of three to four students follow the instruction manual for assembling and operating the ionization rate meter ("Cutie Pie") and the condenser R-meter. The teacher should monitor the class and answer student questions. When each member of each group can assemble and operate his assigned meter without error, the group will follow through with the other rate meter.

b. Obtain permission to visit a doctor's or dentist's office to inspect an x-ray machine, or obtain a microwave oven. Each student will proceed to monitor the roentgen output for the radiation source with the meters noted in C.1.a. Have the operator discuss safety precautions taken to ensure safety for personnel.

2. Using a microwave oven, have students use either the ionization rate meter or the condenser R-meter to measure the roentgen emissions. Students will compare results.

3. Visit the nearest air pollution control agency or health department which conducts surveys of electronic radiation products. Have an inspector or official explain those procedures his department uses to conduct a survey. Ask him to provide survey forms for the students to examine.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Have each student set up and operate both the ionization rate meter

("Cutie Pie") and the condenser R-meter, under supervision, in a simulated field assignment.

2. Have each student determine (from the operations in D.1.) roentgen output from each meter in milli-roentgens per hour.

3. Students must identify (short answer format) the kinds of information to be obtained in an electronic radiation product survey, given the following categories:

    a. Survey preparation

    b. Survey interview

    c. Physical survey

    d. Survey conclusion

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Ionization rate meter ("Cutie Pie") and condenser R-meter

2. Survey forms: dental x-ray, medical x-ray, microwave oven

F. EXAMPLES OF SUPPORTING REFERENCES

1. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

    This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

2. Henry, Hugh F. Fundamentals of Radiation Protection. New York, New York: Wiley-Interscience. 1969, 485 pages.

    This publication describes the principles guiding the implementation of a radiation-protection program. It also provides an overall subject of radiation and its hazards and control.

[illegible]. *Physical Survey Manual Dental X-Ray*. Rockville, Maryland: National Center for Radiological Health, U.S. Department of Health, Education and Welfare. 1967, 129 pages.

Though this publication covers the complete radiation inspection of dental x-ray installations, it serves as a standard guide to the general electronic product survey. Included are instructions for operating the ionization rate chamber and calculating the results.

NOISE ASSESSMENT

UNIT CONCEPT: Many human activities including transportation, construction, and industrial operations generate noise that, if not controlled, can reach levels which cause many persons discomfort, irritation and, in severe cases, loss of hearing. By measuring noise levels emitted by these sources, those hazardous sound levels (and their sources) which have been determined illegal can be detected and provide a basis for reducing them to a satisfactory level.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given the manufacturer's manual of instructions, operate and read a sound-level (decibel) meter, to within 5 decibels.

2. Given the manufacturer's manual of instructions, read fluctuations in noise level during specific time intervals on the decibel meter strip-chart, to determine if noise levels comply with or exceed maximum limits of acceptability. These regulations may be federal, state, or local in scope.

3. Given transportation noise from a single source, conduct a spot check evaluation of the noise level, using criteria established by the U.S. Environmental Protection Agency in Noise Source Regulations in State and Local Noise Ordinances.

4. Given overall transportation noise from a highway, roadway, or airport, evaluate a residential site's exposure to transportation noise, using the decibel meter strip-chart recorder and "Noise Level Guidelines" chart, U.S. Department of Transportation.

5. Given the Noise Exposure Forecast contour and a map of an air operations area, evaluate a site's exposure to noise, applying acceptability standards set by the U.S. Department of Housing and Urban Development.

B. INSTRUCTIONAL AREAS

1. Introducing noise as a potentially harmful air "pollutant"

    a. Comparing standard noise levels emitted from specific noise sources (measured in decibels) with health effects

    b. Examples of different noise emission standards set for specific noise sources in specific states

2. Conducting two types of noise evaluations

    a. Conducting the spot check survey of specific sources

        (1) Purpose of the spot check evaluation
        (2) Distance from meter to noise source
        (3) Instrument - the manual decibel meter (see B.3.a.)
        (4) Number of readings; averaging readings

    b. Conducting the residential noise exposure evaluation of noise sources over a 24-hour period

        (1) Purpose of the residential noise exposure evaluation
        (2) Distance from meter to noise source
        (3) Selecting the site most representative of severe noise exposure
        (4) Instrument - the continuous decibel meter strip-chart recorder (see B.3.b.)

3. Instruments used to measure noise levels

    a. Using the manual decibel meter for quick spot checks and surveys

        (1) Identifying component parts
        (2) Position of meter for monitoring noise
        (3) Operating the manual decibel meter
        (4) Taking readings (in decibels)
        (5) Recording readings
        (6) Calculating average reading when taking a survey

    b. Using the decibel meter strip-chart recorder for continuous, unattended noise level monitoring

- (1) Identifying component parts (in addition to manual meter)
- (2) Mounting the sound meter for monitoring noise
- (3) Operating the instrument
- (4) Taking cumulative noise level readings, reading fluctuations in noise level over an extended number of hours, using the strip chart

4. Determining the acceptability of noise using specific standards for spot checks and for evaluating residential noise exposure

   a. Spot check survey results

      - (1) Recording the average noise level in decibels (from the sum of readings)
      - (2) Match resultant reading with the legal standard for that particular noise source (Noise Source Regulations in State and Local Noise Ordinances, U.S. Environmental Protection Agency)

   b. Residential site exposure results

      - (1) Recording the cumulative noise exposure
      - (2) Recording the minutes/hours that specific noise levels were exceeded in a 24-hour period
      - (3) Match results with standards ("Noise Level Guidelines") set by appropriate agency

   c. Determining the acceptability of aircraft noise using Noise Exposure Forecast contours described in Noise Assessment Guidelines, published by the U.S. Department of Housing and Urban Development

5. Using Noise Assessment Guidelines to determine the acceptability of a site's exposure to transportation noise (without using the decibel meter)

   a. Purpose of the "guidelines"

   b. Disadvantages of the "guidelines"

   c. Description of evaluating a site's exposure to:

(1) Railway noise
(2) Highway noise
(3) Aircraft noise

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Each student will practice measuring the sound pressure level in decibels, using a manual decibel meter. Spot checks of noise levels can be made of any machinery noise within the classroom. (Students may bring in recordings of common appliance noises found in the home, and test the sound levels involved.)

2. Sample strip charts (with 12-hour noise recordings) will be distributed throughout the class. Students will break up into groups of three or four to determine how many minutes and hours certain sound levels occurred in total.

3. Students will take spot checks of single transportation noise sources (using the manual decibel meter) for the following sources:

   a. Motorcycle (35 miles per hour - MPH - or less);

   b. Automobile (35 MPH or less);

   c. Airport (50 feet from boundary).

4. Students will visit a residential site near one of the following transportation noise sources: highway, railway, or aircraft. (A site should be selected where there is moderately heavy traffic.) Students will set up the decibel meter strip-chart recorder and monitor the noise level for a 24-hour period. Students will determine the acceptability of noise at the site.

5. a. Students will take a field trip to a municipal airport. They will meet the director of the Federal Aviation Administration or the airport operator to discuss uses of the Noise Exposure Forecast contours. (You may ask for sample contours and airport maps.)

   b. Students will each be given uniform schematic maps of an area and Noise Exposure Forecast contours to determine the acceptability of noise exposure at the site.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. In the classroom, each student will listen to five recordings of sounds (jet take-off, alarm clock, pneumatic drill, freeway traffic, loud music, etc.). Using a manual decibel meter, the student will determine the decibel reading of each, to within 5 decibels of the correct reading.

2. Twelve-hour strip charts will be distributed to each student. Each student will be asked to determine, without error:

    a. Points on the chart at which the noise exceeded the 90dB (decibel) maximum safe noise level

    b. Total time (if any) noise levels exceeded:

        (1) 80 dB
        (2) 75 dB
        (3) 65 dB

    c. The noise acceptability category indicated by the chart

3. Each student must conduct a spot check evaluation of the noise level of specific sources at a highway (automobiles). He must take readings for twenty automobiles and average the results. He must:

    a. Set up and operate the decibel meter, without error

    b. Record each reading within 5 decibels of the correct reading

    c. Average the results, without error

4. Each student must conduct a residential site exposure noise evaluation. He must:

    a. Maintain and operate the decibel meter strip-chart recorder, without error

    b. Record the cumulative noise exposure, without error

    c. Determine noise acceptability, without error

5. Mimeographed maps with a Noise Exposure Forecast contour and a Noise Assessment Acceptability chart will be given to each student in class. Without error, each student must:

    a. Locate the residential site

    b. Locate the major runway center point

    c. Connect these points

    d. Measure the distances

    e. Evaluate the site's exposure to aircraft noise

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Maps of the following areas: residential area and adjacent highway, residential area and adjacent railway, residential area and adjacent airport; a ruler or straight edge; a pencil; a 100-foot tape measure; a worksheet

2. Noise Exposure Forecast noise level contours

3. Table (chart) - Noise Level Guidelines and NEF Contours (General Exposure dBA), U.S. Department of Transportation

4. Table (chart) - Site Exposure to Aircraft Noise, U.S. Department of Housing and Urban Development

5. Manual decibel meter and the decibel meter with continuous strip-chart recorder

F. EXAMPLES OF SUPPORTING REFERENCES

1. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

    This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

2. Handbook of Noise Measurement. West Concord, Massachusetts: General Radio Company. 1967, 282 pages.

   This is an excellent technical handbook for descriptions of noise monitoring devices and their use.

3. Noise Assessment Guidelines. Washington, D.C.: U.S. Department of Housing and Urban Development. 1971, 20 pages.

   This publication presents methods for evaluating a site's exposure to railway, roadway, and aircraft noise without the use of the decibel meter,

4. Noise Source Regulations in State and Local Noise Ordinances. Washington, D.C.: Office of Noise Abatement and Control, U.S. Environmental Protection Agency, U.S. Government Printing Office, Superintendent of Documents. 1973, 13 pages.

   Prepared to give public administrators and other officials an accurate overview of noise control regulations at the state and local level, this document summarizes current state and local laws and ordinances dealing with ground transportation systems, noise from construction equipment, across property lines, and others.

5. Operating Manual of Instructions for Sound Measuring/Monitoring Instruments. Allison Park, Pennsylvania: Research Appliance Company. 1972, 10 pages.

   An instruction manual, this publication includes all operational and maintenance procedures for the sound measuring instruments.

6. Transportation Noise and Its Control. Washington, D.C.: U.S. Department of Transportation. 1972, 27 pages.

   This publication explains sound measurement (in decibels), the nature of railway, roadway and aircraft noise, an acceptability criteria for sound levels, developed by the Department of Transportation.

COMPLAINT INVESTIGATION AND TESTIFYING IN COURT

UNIT CONCEPT: The air pollution inspector investigates citizen complaints to locate and determine if a violation has taken place. He may be called upon to report his findings in a court of law. A good testimony will depend upon a complete knowledge of the violation from the complaint investigation.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given a simulated complainant who is not directing his grievance toward a specific source, role-play an investigation of a general air pollution complaint by telephone, creating an effective control agency image.
2. Given a simulated complainant who is directing his grievance toward a specific source, role-play an investigation of a specific source complaint on location, using procedures recommended by the Environmental Protection Agency, Office of Manpower Development.
3. Using the complete and factual details from an investigation of the source, testify in a simulated court case of a citizen suit, according to criteria recommended by the Environmental Protection Agency, Office of Manpower Development.

B. INSTRUCTIONAL AREAS

1. Handling the general air pollution complaint
    a. Letting the complainant voice his grievances, without interruption
    b. Informing the citizen of the air pollution control department activities to abate the situation

        (1) Progress being made
        (2) Problems and obstacles of control being encountered

    c. Producing an effective agency image

        (1) Admitting the agency's problems
        (2) Honesty
        (3) Exhibiting firmness
        (4) Emphasizing progress

    d. Evaluating the honesty of the complainant

2. Handling the specific source complaint

    a. Observing the source from complainant's property while the nuisance is in progress, if possible

        (1) Applying the appropriate method of "measurement" evaluation (smoke chart, decibel meter, odor intensity/quality)
        (2) Recording data from evaluation on appropriate report form

    b. Meeting the complainant directly after the source has been observed

        (1) Listening carefully to the complainant to gather facts and let complainant "speak his mind"
        (2) Recording significant information and specific words which describe the grievance in common terminology

    c. Conducting the inquiry using direct questioning techniques to check for substantiating evidence of validity

        (1) Determining the cause of the complaint
        (2) Determining the nature and the source of the air pollution problem cited in the complaint

    d. Surveying the complainant's property for any evidence of damage, is possible; examining the property for any deposits or effects of contaminants

3. Inspecting the specific source in question of violation

- a. Tracking the source
    - (1) Checking the pattern of contaminant fallout
    - (2) Determining the prevailing wind direction
    - (3) Identifying the contaminants
- b. Contacting the party suspected of responsibility for a violation
    - (1) Explaining the purpose of the investigation
    - (2) Giving the party an opportunity to state his case
    - (3) Recording information from party's statement on appropriate form
    - (4) Using direct questioning from facts supplied by the suspected party
- c. Inspecting the general equipment which may be responsible for violation
    - (1) Times and cycles of operation
    - (2) Nature of the process involved
    - (3) General description of machinery/equipment
    - (4) Comparing times/cycles with times and frequencies of complaints

4. Writing the complaint report (see unit entitled "Air Quality Reports")

5. Ethics of the air pollution inspector when investigating a complaint
    - a. Assuming an attitude of indifference
    - b. Acting as an unbiased mediator
    - c. Being straightforward

6. Testifying in a court trial when a citizen brings a suit against an industry or private citizen which you have investigated
    - a. Preparing testimony used to establish the inspector's competence by describing:
        - (1) General job duties, title, etc.
        - (2) Previous employment-educational experience

(3) Length and nature of in-service training
(4) Smoke school training

b. Preparing testimony needed during a cross examination

(1) Re-checking complaint-source report data for accuracy and completeness
(2) Collecting any evidence from the complainant's residence (specimens, photographs)
(3) Making a list of the questions you may be asked and the best corresponding answers
(4) Memorizing data
(5) Reviewing testimony with District Attorney, senior inspector, or the supervisor of the air pollution department

c. Creating a favorable impression on others in the courtroom

(1) Dress
(2) Behavior
(3) Exuding self-confidence

d. Supporting a solid testimony with solid public speaking techniques

(1) Using correct grammar
(2) Selecting words carefully
(3) Speaking simply and directly
(4) Directing testimony to the appropriate audience (judge or jury)
(5) Avoiding speech crutches

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. & 2. Take a field trip to a nearby air pollution control department, or have an official from such a department come to the classroom to discuss procedures for handling complaints. Students should develop questions for a discussion session.

a. Simulate a complaint investigation in which one student role-plays the complainant and the other student role-plays the inspector. The teacher will provide the situation or other students may provide suggestions of circumstances involving a complaint. A discussion and critique will follow.

b. Students will role-play a source investigation. The inspector must seek information from the responsible party at the source who refuses to admit responsibility. Ten complaints were brought against the industry.

3. a. A detailed description of circumstances leading to a court case will be distributed throughout the class. The specific trial procedures and verdict will be omitted. The class will divide into four groups, each responsible for preparing one member of the group as: air inspector, defense lawyer, prosecuting attorney, and defendant. Remaining students will collectively act as a jury for the mock trial.

   b. Students will discuss the weaknesses which lost the case and the strengths which determined the verdict in exercise C.3.a. Emphasis will be placed upon indicating the strengths of the inspector's testimony and his total effect of credibility.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Five tape recordings of simulated telephone conversations between a complainant and an inspector will be presented to the class. In each recording the inspector fails to perform appropriately. Each student must indicate what should have been done, choosing from a multiple choice format.

2. Short essay - "You Are There." Four situations are presented to the students on paper. Two situations involve a problem confronted at the complainant site; two situations involve a problem confronted at the source site. It is the student's responsibility to indicate a workable approach to the problem.

3. Short essay - The testimony and cross-examination of an inspector will be played by recording before the class. A duplication of this recording will be passed out to each student. Students must evaluate the inspector's testimony and performance according to the recommended criteria given in class.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Hand-outs describing mock situations for role-play exercises; a hand-out describing the circumstances preceding a trial involving a citizen suit

2. Tape recorder, tapes of simulated telephone conversations

F. EXAMPLES OF SUPPORTING REFERENCES

1. Air Pollution Control Field Operations Manual. Washington, D.C.: U.S. Department of Health, Education and Welfare, U.S. Government Printing Office. 1962, pp. 101-114, 135-139.

   This publication was originally prepared as a training manual for field personnel in the Los Angeles district. This manual describes, in detail, the field inspection and enforcement activities required in the L.A. county control program.

2. Air Pollution Field Enforcement. Washington, D.C.: Environmental Protection Agency, Office of Manpower Development, U.S. Government Printing Office. 1969

   A course manual, this publication covers the areas of air pollution control, atmospheric sampling and analysis, field studies and air quality management. It includes a detailed "how to" description of testifying in court.

3. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

   This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspecter I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

AIR QUALITY REPORTS

UNIT CONCEPT: Reporting the results of sampling and investigation procedures, accurately and objectively, provides evidence of compliance or non-compliance with air pollution standards and laws, and provides evidence of changes in pollutant levels.

A. STUDENT PERFORMANCE OBJECTIVES

The student should be able to:

1. Given results of filed weekly air surveillance reports from the sampling and analysis of gases and particulates, report in writing the averaged results from gaseous and particulate samples taken for one month in a monthly survey report, eliminating complex or technical terminology.

2. Given the respective source-complaint investigation forms, report in writing the results obtained from complaint investigations of open burning, stationary and moving smoke sources, odors, and noise according to:

    a. Facts obtained from the interview with the complainant

    b. Observations of excessive odors, noises, or smoke emissions

3. Given a complaint report or monthly survey report, evaluate the collection of data and evidence on a report, according to the following criteria:

    a. Conciseness

    b. Objectivity

    c. Clarity

    d. Completeness

    e. Readability

    f. Accuracy

B. INSTRUCTIONAL AREAS

1. The importance of reports
    a. The value of reports to court cases involving citizen suits
    b. The value of reports as evidence of compliance with air pollution regulations
2. Writing specific reports for the air pollution department
    a. Writing the monthly survey report
        (1) Purpose of the report
        (2) Data to be collected
        (3) Format of the report
        (4) Criteria: limited technicalities, public comprehension
    b. Writing the source inspection report for boiler or furnace inspection
        (1) Purpose of the report
        (2) Data to be collected
        (3) Technical form to be filled out
    c. Writing the source-complaint report
        (1) Purposes of the report
        (2) Data which must be recorded for all source-complaint reports
            (a) Obtaining facts from interview with complainant
            (b) Obtaining facts from the inspector's own observations of the source
        (3) Technical forms for reporting open burning, smoke emissions, odors, and noise
        (4) Stating findings in your own words
3. Critical characteristics of reports
    a. Writing a concise report
        (1) Omitting unnecessary details
        (2) Replacing long sentences with shorter, more direct sentences

b. Writing an objective report

  (1) Supplying the reader with no more than you can prove
  (2) Weighing all evidence before drawing conclusions
  (3) Avoiding any appeals to prejudice or private interests

c. Writing a clear report

  (1) Defining terms
  (2) Reporting in a logical sequence
  (3) Including specific details when necessary

d. Writing a complete report by supporting general statements with evidence

e. Writing a readable report

  (1) Writing in a "language" suitable to your audience
  (2) Correcting any spelling errors

f. Writing an accurate report by correcting any errors of:

  (1) Measurement
  (2) Conditions
  (3) Definitions
  (4) Descriptions
  (5) Interview statements
  (6) Problems

C. EXAMPLES OF STUDENT LEARNING ACTIVITIES

1. Students will be given 24-hour results from gaseous and particulate sampling procedures over a period of one month. Each student will average the levels of suspended particulates using the high volume sampler, and suspended particulates using the dustfall collector.

2. Practice with source-complaint investigation forms can be done by role-playing. A few students will be given a situation to complain about. Other students will act as inspectors after being chosen by the instructor or at random. Before the class, each two students will act out a complaint investigation. After the interview, the "inspector" must write a report. The next day, his report will be evaluated by the rest of the class.

3. Mock copies of monthly "news release" reports will be distributed throughout the class. Students will break up into groups of three or four to critique their report. Each group will recommend necessary changes to improve the quality of the report, basing recommendations on the criteria in A.3.

D. EXAMPLES OF PROCESSES TO EVALUATE STUDENT PERFORMANCE

1. Students will write a monthly news release report for their community using the following data:

    a. Particulate levels (hi-vol.) = Site no. 1 (421)
    Site no. 2 (356)
    Site no. 3 (350)
    Site no. 4 (313)
    Site no. 5 (296)

    b. Dustfall = Site no. 1 (81)
    Site no. 2 (57)
    Site no. 3 (45)
    Site no. 4 (42)
    Site no. 5 (37)

    c. Sulfation rates = Site no. 1 (4.0)
    Site no. 2 (2.7)
    Site no. 3 (1.6)
    Site no. 4 (1.6)
    Site no. 5 (1.6)

2. A tape recording will be played before the class of a complainant and an inspector conducting an interview. Students will all be given complaint forms to fill as completely as possible, following criteria set in A.2. and characteristics of a good report in A.3.

3. Copies of student reports from D.2. will be made and distributed throughout the class. Each student will have a copy of a report written by another student. Students will critique their reports following criteria from A.3. Each student must justify why he feels each criteria is or is not met and offer suggestions for improvement.

E. INSTRUCTIONAL MATERIALS OR EQUIPMENT

1. Tape recorder, tapes

2. Samples of monthly survey reports and source-complaint reports

3. Source-complaint report forms with differing formats

F. EXAMPLES OF SUPPORTING REFERENCES

1. Air Pollution Control Field Operations Manual. Washington, D.C.: U.S. Department of Health, Education and Welfare, U.S. Government Printing Office. 1962, pp. 204-208, 215-222.

   This publication was originally prepared as a trining manual for field personnel of the Los Angeles district. This manual describes, in detail, the field inspection and enforcement activities required in any effective air pollution control program.

2. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

   This manual provided much of the source background for this Air Pollution Curriculum Guide. A student manual, this reference comprises a job description of the Air Inspector I, detailed descriptions of the tasks to be performed, student activities, and publications and audio-visual reference lists.

APPENDIX A

RECOMMENDED MATERIALS OR EQUIPMENT

These lists of equipment, supplies and other instructional aids can be used as guides in ordering and assembling those items needed. Each occupational area is dealt with separately in this section.

Some state departments may have more definitive lists available and it may be well to request these as additional sources of information. In addition, experience can be an important factor in developing lists.

WATER TREATMENT

Harvard trip balances
Autoclave capable of operating at 15 lbs. pressure, 121° C.
Oven capable of operating at 170° C.
Incubator capable of maintaining constant temperature of 34° - 36° C.
Vacuum source
Low power microscopes with 10-15X magnification
Compound microscopes, 100X
Water baths, thermostatically set for 43° - 45° C.
Illuminated colony counters
Electric motors
Pumps
Bunsen burners
pH comparators with standard color discs, glass tubes to fit each
Phipps Byrd variable speed jar test apparatus
Jackson candle
50 milliliter burettes
Burette stands
Graduated cylinders - 10, 50, 100, and 500 milliliters
Erlenmeyer flasks - 250 and 125 milliliters
Fermentation tubes without lip - 1 and 10 milliliter, inner tubes,
    50-75 x 5-10 millimeter, without lip
Tube baskets
Sample bottles
Wash bottles
Beakers - 50 and 1,000 milliliter
Glass funnels, 6 inch
Funnel supports

WATER TREATMENT (Continued)

Mohr measuring pipettes, 10 milliliter capacity and graduated in 1/10 milliliters
Transfer pipettes, 1 milliliter
Dropper pipettes
Nessler tubes, short form, 100 milliliter
Nessler A.P.H.A. high-form color comparison tubes, 50 milliliter, assorted
Color tube supports for high-form Nessler tubes
Petri dishes, glass or presterilized plastic, 60 x 15 millimeter and 100 x 15 millimeter with porous covers
Pyrex vacuum flasks, 1,000 milliliter
Pyrex milk dilution bottles with rubber stoppers
Cotton plugs or plastic closures for fermentation tubes
Rubber stoppers, one-hole #0
Glass u-tubes to fit rubber stoppers, one arm 1 inch longer than the others
Stainless steel forceps, smooth inner surface, round-tipped
Inoculating loops for transferring cultures, 24 gauge wire, loop must be 3 millimeter
Glass stirring rods
Glass beads, 1 pound
Filter paper, Whatman #30, 180 millimeter diameter
Filter membranes, 47 millimeter diameter, grid marked
Absorbent pads, 47 millimeter diameter
Dehydrated MF-endo broth
Buffered dilution water
Dehydrated bacto-tryptone glucose
Yeast agar

Special Equipment for the Area

Supplies for microscopic examination of water:
    Standard Sedgewick-Rafter counting cell with extra cover slips
    Sedgewick-Rafter funnels
    Wooden rack to hold funnels
    Silk bolting cloth discs 3/8 inch diameter, 200 meshes/inch
    Standard washed and graded sand ready to use in Sedgewick-Rafter method of filtration

Reagents for the following tests:
    Color -
        100 milliliters of platinum, cobalt color standard, 500 units

WATER TREATMENT (Continued)

- Alkalinity -
    - N/50 sulfuric acid
    - Methyl orange or methyl purple indicator solution, 0.5 grams/liter, or bromcresol green - methyl red indicator solution
- Coagulation -
    - Coagulant [illegible] of 17.7 grams/liter of alum
- Iron and manga[illegible]
    - Hydrochloric [illegible]ne
    - Hydroxylamine reagent
    - Ammonium acetate buffer solution
    - Phenanthroline solution, 0.1 gram dissolved in 100 milliliters of distilled water
- Hydrogen-ion concentration - pH value
    - Indicator solutions, covering pH ranges anticipated
- Bacteria of coliform group -
    - Dehydrated lactose broth
    - Dehydrated brilliant green lactose bile broth, 2%

WASTEWATER TREATMENT

- Test tubes
- Culture tubes, without lip
- Beakers, 200 milliliter
- Funnels
- Erlenmeyer flasks, wide mouth
- Boiling flasks, flat bottom and short neck round bottom
- Filtering flasks
- Volumetric flasks
- Condenser
- Distilling flask
- Buchner funnel with perforated plate
- Reagent bottles
- BOD bottle
- Graduated cylinders
- Procelain crucibles
- Gooch porcelain crucibles
- Evaporating dishes
- Shallow form evaporating dishes
- Support, burette and burette clamp
- Burette

WASTEWATER TREATMENT (Continued)

Burette, automatic
Beaker clamp with safety tongs
Dish clamp with safety tongs
Flask clamp with safety tongs
Test tube clamp
Utility clamp
Clamp
Clamp holder
Concentric ring tripod
Bunsen burner
Fused triangle
Imhoff cone
Cone support
Volumetric pipette
Serological pipette
Petri dish
Dial thermometer
Nessler color comparison tubes
Desiccator
Hot plate
Mechanical convection oven
Electric muffler furnace
BOD cabinet
Analytical balance with reading scale, weight 95.5580 grams
pH meter
Air pressure and vacuum pump
Spectrophotometer
Test paper, pH 1-11

AIR POLLUTION CONTROL

Ambient Air Sampling Equipment

- Hi-Volume air samplers, with shelters and vacuum pumps
  - Hi-Volume filter holders
  - 8 x 10 inch fiberglass or cellulose filters
  - Orifice calibration kit
- Automatic tape spot samplers, with chassis and vacuum pumps
  - Particulate filter paper tapes
- Automatic fluoride tape spot sampler, with chassis and vacuum pump
  - Particulate fluoride filter paper tapes
  - Gaseous fluoride filter paper tapes

AIR POLLUTION CONTROL (Continued)

- Lead peroxide candles, with shelters and stanchions
    - Lead peroxide powder
    - Gauze tubes
- Dustfall collectors
    - Distilled water
- Cascade impactor, with shelter and vacuum pump
    - Aluminum collection disks
    - 4 inch glass or membrane fiber filters
    - Impactor backup filters
- Adhesive impactors
    - Sticky adhesive papers
    - Lacquer spray
- 5-Gas sampler assembly
    - Plastic filter holders
    - Glass wool
    - Reagents (see "Special Equipment" on the following page)

Combustion Equipment

- Ringlemann, or Ringlemann-type Smoke Chart
- Dial thermometer, with probe
- Draft gauge, with probe
- Basic carbon monoxide indicator assembly
    - Carbon monoxide indicator tubes, or
    - Carbon monoxide indicator sampler indicator tubes
    - Carbon dioxide analyzer assembly

Noise Equipment

- Sound level (decibel) meter

Radiation Equipment

- Ionization chamber survey monitor
- Pocket dosimeter/film badge
- R-meter with 2-25r chambers
- Lead x-ray tube port plug
- "Circular Calculator" wheels

Meteorological Instruments

- Wind anemometer

AIR POLLUTION CONTROL (Continued)

Wind vane
Dual-channel strip-chart recorder
  Chart paper for recorder
  50 feet of cable
Thermometer
Hygrometer and supply of recording paper

Analyzing Equipment

Tape spot evaluator
COH conversion charts
Gruber particulate comparator
Desiccator
Torsion analytical balance
Illuminated magnifier
Carbon monoxide color charts

Accessory and Furnace Room Equipment

Muffle furnace with 9 1/2 x 8 1/2 x 13 1/2 inch chamber
Hot plates, thermo-regulated, 750° F.

Miscellaneous Equipment

Forceps
Circular recording charts
Timers (one for each instrument requiring a timing device)
20-mesh sieves
Scissors
Gooch crucibles
Porcelain crucibles
Pyrex beakers, 1,000 milliliter
Evaporating dish
Rubber stopper assortment
Rotameter
Sampling probes, 4 foot and 8 foot
Sampling nozzles, 3/8 inch and 1/2 inch
Polaroid camera, black and white film
Stop watch

Special Equipment (reagents)

Ozone Determination (neutral buffered potassium iodide method):

AIR POLLUTION CONTROL (Continued)

Standardized iodine solution
Neutral buffered potassium iodide absorbing
Double distilled water

Nitrogen Dioxide Determination (24-hour sampling method):
Sulfanilamide
Standard nitrite
Hydrogen peroxide solution
NEDA solution

Sulfur Dioxide Determination:
Starch indicator solution
Formaldehyde solution
Sodium sulfite
Iodine solution
Standardized thiosulfate
Pararosaniline
TCM absorbing reagent

Hydrogen Sulfide Determination:
Stock amine test solution
Sodium hydroxide (absorbing reagent)
Ferric chloride solution
Cadmium sulfate (absorbing reagent)
Concentrated sulfuric acid

Ammonia/Ammonia Compound Determination:
Alkaline rochelle salts
Folin's Nessler reagent
Standard Ammonium chloride solution
Dilute sulfuric acid absorbing reagent

Aliphatic Aldehyde Determination:
MBTH absorbing reagent
Oxidizing reagent
Formaldehyde solution

Additional Activities Equipment

Tape recorder
Tapes or cassettes
Slide projector

AIR POLLUTION CONTROL (Continued)

Screen
Movie projector
Microwave oven (rental)
Environmental chamber (experiment manual; fabric strips, rubber strips, painted surfaces)
Smoke generator
Relief maps/models of different topographical types
Mixing buckets, plaster of paris, wire mesh
100-foot tape measures
Slats, nails, concrete blocks (enough for each sampler)
Aspirator bulbs and tubing
Side-arm filter flasks
Glass tubing (several pieces to match stopper hole diameter)

Safety Equipment

Goggles
Fire extinguishers
First aid cabinet
Leaded apron

APPENDIX B

SUGGESTED REFERENCES FOR INSTRUCTIONAL UNITS

The following suggested references were cited within the instructional units of the three occupational areas included in this guide and they are arranged according to these areas. Additional instructional aids for the Air Pollution Control area follow the reference section for the area.

References General to the Environmental Protection Area

Bender, Ralph E. The FFA and You. Danville, Illinois: The Interstate Printers and Publishers, Inc. 1962, 494 pages.

Course of Study in Agricultural Occupations. Lexington, Kentucky: Department of Agricultural Education, University of Kentucky. 1967, 262 pages.

Human Relations in Business. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1971, 70 pages.

Membership - Pathway to Leadership. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1972, 23 pages.

Occupational Opportunities in Environmental Management. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1972, 48 pages.

Official Manual, Future Farmers of America. Alexandria, Virginia: Future Farmers Supply Service. 1972, 128 pages.

Opportunities in Agricultural Occupations and the Employee within the Business Organization. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1971, 68 pages.

Resource Unit on Human Relations. Tucson, Arizona: Department of Agricultural Education, The University of Arizona. 1971, 90 pages.

Stewart, W. F. Helps in Mastering Parliamentary Procedure. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1969, 17 pages.

Water Treatment

Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, 1,230 pages.

Manual of Instruction for Water Treatment Plant Operators. Albany, New York: New York State Department of Health. 308 pages.

Water Works Operation. College Station, Texas: Engineering Extension Service, Texas A & M University. 318 pages.

Wastewater Treatment

Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970, 1,230 pages.

Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health. 247 pages.

Air Pollution Control

Air Pollution. Volume I. New York, New York: Academic Press. 1968.

Air Pollution Control Field Operations Manual. Washington, D.C.: U.S. Department of Health, Education and Welfare, U.S. Government Printing Office. 1962, 285 pages.

Air Pollution Field Enforcement. Washington, D.C.: Environmental Protection Agency, Office of Manpower Development, U.S. Government Printing Office. 1969.

The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1974.

Air Pollution Primer. New York, New York: National Air Conservation Commission, National Tuberculosis and Respiratory Disease Association. 1969, 104 pages.

A.I.S.I. Automatic Samplers, Operating Instructions. Allison Park, Pennsylvania: Research Appliance Company.

Collection and Analysis of Dustfall: Instructions. Allison Park, Pennsylvania: Research Appliance Company.

Community Odor Surveys and Evaluation. Cincinnati, Ohio: Division of Air Pollution, Robert A. Taft Sanitary Engineering Center. 1965, 12 pages.

Educational Air Pollution Study Kit. Allison Park, Pennsylvania: Research Appliance Company.

Evaluations of Visible Emissions. Columbus, Ohio: Battelle Laboratories. 1973.

5-Gas Collecting Sampler, Operating Instructions. Allison Park, Pennsylvania: Research Appliance Company. 21 pages.

Gruber, Charles W. *A Summary of Recommended Standard Methods for Measuring Wind-Blown Nuisance Particulates*. Allison Park, Pennsylvania: Research Appliance Company.

Guidelines: Air Quality Surveillance Networks. No. AP-98. Research Triangle Park, North Carolina: Office of Air Programs, Environmental Protection Agency. 1971, 16 pages.

Handbook of Noise Measurement. West Concord, Massachusetts: General Radio Company. 1967, 282 pages.

Henry, Hugh F. *Fundamentals of Radiation Protection*. New York, New York: Wiley-Interscience. 1969, 485 pages.

Introduction to Air Pollution Control. Washington, D.C.: The Office of Manpower Control, The Institute of Air Pollution Training. 1969.

Noise Assessment Guidelines. Washington, D.C.: U.S. Department of Housing and Urban Development. 1971, 20 pages.

Noise Source Regulations in State and Local Noise Ordinances. Washington, D.C.: Office of Noise Abatement and Control, U.S. Environmental Protection Agency, U.S. Government Printing Office, Superintendent of Documents. 1973, 13 pages.

Operating Manual of Instructions for Sound Measuring/Monitoring Instruments. Allison Park, Pennsylvania: Research Appliance Company. 1972, 10 pages.

Physical Survey Manual Dental X-Ray. Rockville, Maryland: National Center for Radiological Health, U.S. Department of Health, Education and Welfare. 1967, 129 pages.

Standard Methods of the Measurement of Ambient Air Quality. Columbus, Ohio: Ohio Environmental Protection Agency. 1973, 84 pages.

Transportation Noise and Its Control. Washington, D.C.: U.S. Department of Transportation. 1972, 27 pages.

Weather Instruments. Dallas, Texas: Texas Electronics, Inc. 12 pages.

Films

The following films are valuable in showing research, testing, and presenting factual information dealing with the occupational area of air pollution control. Films are listed to correspond with the appropriate units.

"The Effects of Particulates and Gases"

Air Pollution
Damage to plants, crops, materials, and control measures
11 1/2 minutes, color, $10 rental, sound, 1969
(Journal Films, Inc., 909 W Diversey Parkway, Chicago, Illinois 60614)

Don't Hold Your Breath
Story of Pittsburgh residents who fought to eliminate air pollution
30 minutes, color, $25 rental, sound, 1972
(Group Against Smog and Pollution, P. O. Box 2850, Pittsburgh, Pennsylvania 15230)

Pollution Front-Line
Air pollution health hazards involved in Hamilton, Ontario
46 minutes, black/white, $30 rental, sound, 1970
(National Film Board of Canada, 680 5th Avenue, New York, New York 10019)

Something in the Air
Social, medical, economic factors of air pollution
28 minutes, color, free loan, sound, 1972
(Modern Talking Picture Service, Inc., 2323 New Hyde Park Road,
New Hyde Park, New York 11040)

The Poisoned Air
Much evidence of air pollution damage, abatement operations in Pittsburgh and St. Louis
50 minutes, black/white, $35 rental, sound, 1966
(Carousel Films, Inc., 1501 Broadway, Suite 1503, New York, New York
10036)

The Slow Guillotine
Effects of pollution, reports from scientists - Jack Lemmon narrates
53 minutes, color, $25 rental, sound, 1969
(NBC Educational Enterprises, 30 Rockefeller Plaza, New York, New York
10020)

"The Effects of Topography and Weather on Air Pollution"

Climatology: Some Causal Factors
8 mm., 4 minutes, sound
(Harper and Row Publishers, Inc., New York, New York 10016)

Origins of Weather
16 mm., 13 minutes, sound
(U.S. Environmental Protection Agency, Technical Audio-Visual Branch,
Research Triangle Park, North Carolina 27711)

Stability and the Weather
16 mm., 21 minutes, silent
(U.S. Environmental Protection Agency, Technical Audio-Visual Branch,
Research Triangle Park, North Carolina 27711)

Smog
8 minutes, black/white, $8.50 rental, sound
(CCM Films, Inc., 866 Third Avenue, New York, New York 10022)

"Particulate and Gaseous Sampling Methods"

Air is for Breathing
29 minutes, color, 1971
(Shell Film Library, 450 N. Meridian Street, Indianapolis, Indiana 46204)

To Conserve and Protect
Causes, effects, noise reduction measures - James Mason narrates
14 1/2 minutes, color, free loan, 16 mm., sound
(Modern Talking Picture Service, 2323 New Hyde Park Road, New Hyde
Park, New York 11040)

"Complaint Investigation and Testifying in Court"

Our Poisoned World: Air
Good study of environmental law, interviews with prominent officials
30 minutes, color, $30 rental, 1970
(Time-Life Films, 43 W. 16th Street, New York, New York 10011)

Don't Hold Your Breath
Effects; also includes a board hearing against a violating coke plant in
Pittsburgh, Pennsylvania
30 minutes, color, $25 rental, 1972
(Group Against Smog and Pollution, P. O. Box 2850, Pittsburgh, Pennsylvania 15230)

Estimation of SO_2 by Lead Candle Methods
16 mm., 24 minutes, color, sound
(U.S. Environmental Protection Agency, Technical Audio-Visual Branch,
Research Triangle Park, North Carolina 27711)

Measurement of Particulate Pollutants
35 mm., 14 minutes, sound
(U.S. Environmental Protection Agency, Technical Audio-Visual Branch,
Research Triangle Park, North Carolina 27711)

"Combustion Evaluation"

After the Smoke Clears
16 mm., 15 minutes, color, sound
(U.S. Environmental Protection Agency, Technical Audio-Visual Branch,
Research Triangle Park, North Carolina 27711)

Calculations of Estimated Emissions
T.V. tape, 20 minutes, Kinescope
(U.S. Environmental Protection Agency, Technical Audio-Visual Branch,
Research Triangle Park, North Carolina 27711)

Source Inventory
16 mm., 15 minutes, black/white, sound
(U.S. Environmental Protection Agency, Technical Audio-Visual Branch,
Research Triangle Park, North Carolina 27711)

Vehicle Emissions Control Story
16 mm., 25 minutes, color, sound
(U.S. Environmental Protection Agency, Technical Audio-Visual Branch,
Research Triangle Park, North Carolina 27711)

"Odor Evaluation"

A Day at the Dump
15 minutes, color, $20 rental
(Stuart Finley, Inc., 224 West Franklin Avenue, Minneapolis, Minnesota
55404)

"Radiation Sampling"

Hot to Handle
Survey of the pros and cons, uses and effects, of atomic radiation
60 minutes, black/white, $25 rental, 1968
(Time-Life Films, 43 W. 16th Street, New York, New York 10011)

"Noise Assessment"

Can We Have a Little Quiet, Please?
Monitoring aircraft noise
14 1/2 minutes, color, free loan, sound, 1971
(Federal Aviation Administration, Film Library AC-44.5, P. O Box 25082,
Oklahoma City, Oklahoma 73125)

Noise: The New Pollutant
Methods for measuring decibel output are demonstrated at length
30 minutes, black/white, $6.75 rental, sound, 1967
(Indiana University Audio-Visual Center, Bloomington, Indiana, 47401)

The Noise Boom
Survey of noise sources, noise reduction measures
26 minutes, color, $15 rental, sound, 1969
(NBC Enterprises, 30 Rockefeller Plaza, New York, New York 10020)

APPENDIX C

SELECTED LIST OF PROFESSIONAL AND TECHNICAL SOCIETIES AND ORGANIZATIONS CONCERNED WITH ENVIRONMENTAL PROTECTION AND ITS APPLICATION

A list of some of the professional, scientific and technical societies concerned with environmental protection may be a useful source of instructional information and reference data. The selected list which follows is not a complete listing of all such organizations. Inclusion does not imply special approval of an organization, nor does omission imply disapproval of an organization. Details regarding local chapters or sections of societies have been omitted.

It is suggested that teachers and others desiring information from the organizations listed below should address their inquiry to "The Executive Secretary" of the organization. A request for information about the organization and its services, or for specific information, usually can be answered promptly by them.

Air Pollution Control Association, 4400 Fifth Avenue, Pittsburgh, Pennsylvania 15213

American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington, D.C. 20005

American Chemical Society, 1155 Sixteenth Street, N.W., Washington, D.C. 20036

American Industrial Hygiene Association, 14125 Prevost Avenue, Detroit, Michigan 48227

American Institute of Chemical Engineers, 345 East 47th Street, New York, New York 10017

American Meteorological Society, 45 Beacon Street, Boston, Massachusetts 02108

American Public Works Association, 1313 East 60th Street, Chicago, Illinois

American Society for Testing Materials, 1916 Race Street, Philadelphia,
Pennsylvania 19103

American Society of Mechanical Engineers, 345 East 47th Street,
New York, New York 10017

American Water Resources Association, P. O. Box 434, Urbana,
Illinois 61801

The Citizens Advisory Committee on Environmental Quality,
1700 Pennsylvania Avenue, N.W., Washington, D.C. 20006

The Conservation Foundation, 1250 Connecticut Avenue, N.W.,
Washington, D.C. 20036

Ecological Society of America, Oak Ridge National Laboratory,
Oak Ridge, Tennessee 37831

Federal Water Pollution Control Administration, U.S. Department of
the Interior, Washington, D.C. 20240

Incinerator Institute of America, 60 East 42nd Street, Suite 1914,
New York, New York 10017

Institute of Environmental Sciences, 34 South Main Street,
Mount Prospect, Illinois 60057

National Council for Air and Stream Improvement, 103 Park Avenue,
New York, New York 10017

National Tuberculosis and Respiratory Disease Association,
New York, New York

National Wildlife Federation, 1412 16th Street, N.W.,
Washington, D.C. 20036

U.S. Environmental Protection Agency, Washington, D.C. 20460

Water Pollution Control Federation, 3900 Wisconsin Avenue,
Washington, D.C. 20016

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